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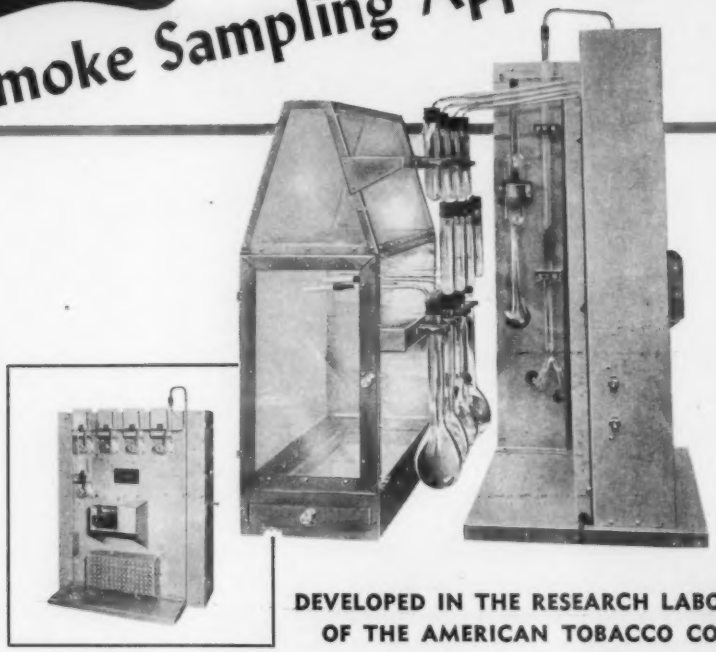

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The Population Reference Bureau

JULIAN HUXLEY has said that "human population is probably the gravest problem of our time. Certainly more serious in the long perspective than war or peace. . . ." The close relationship of population to war and peace is obvious to all who understand population trends.

The Population Reference Bureau, Inc., has, since it was founded in 1929 by the late Guy Irving Burch, pioneered in its endeavor to awaken public interest in the problem. A nonprofit, scientific organization which is sponsored by a group of biologists, sociologists, and economists, the Bureau gathers, coordinates, and distributes population data. Its Board of Trustees consists of Dr. C. C. Little, Director, Jackson Memorial Laboratory, Bar Harbor, Maine; Donald J. O'Connor, Director, The Office of Puerto Rico, Washington, D.C.; Mrs. Guy Irving Burch, Arlington, Virginia; Samuel W. Anderson, Assistant Secretary of Commerce, Washington, D.C.; Dr. Kingsley Davis, Sociologist-Demographer, Bureau of Applied Social Research, Columbia University, New York, N.Y.; Dr. Clarence J. Gamble, Co-Director, College Project, Milton, Mass.; Dr. Frank H. Hankins, distinguished emeritus professor of sociology at Smith College, Northampton, Mass.; Dr. Joseph J. Spengler, economist, Duke University, Durham, N.C.; and William Vogt, National Director, Planned Parenthood Federation of America, New York, N.Y. Robert C. Cook is Director of the Bureau.

A steadily growing awareness of population problems on the part of the public has been the Bureau's reward for its pioneering effort. Today the Bureau is a clearing-house for population information. Its main objective is to make available in accurate, nontechnical form the essential facts upon which rational population policies must be based. It does not sponsor action programs to implement population policies in either their quantitative or qualitative aspects. A three-year grant from the Ford Foundation in August 1952 has made it possible to strengthen and further develop the Bureau's program.

Since 1945 one of the Bureau's main activities has been the publication of its *Population Bulletin*, which is used as a source of demographic information by teachers, students, libraries, laymen, editors, publishers, news and editorial writers, columnists, radio commentators, businessmen, and industrial consultants. Each issue is devoted to some particular aspect of the population problem, or to an analysis of the demographic "health" of a particular country. Subjects recently covered by the *Bulletin* include: Latin America, Area of Population Explosion; Italy, A Population Paradox; Falling Birth Rates —What Do They Mean?; Soviet Population Policy; and Why People Refuse to Face Population Problems. Two issues, devoted to U.S.A. A.D. 1975–2000, anticipate population growth in terms of the consumption of resources. A third issue of this series, scheduled for 1954, will deal with the qualitative aspects of population change.

Since 1946 the Bureau has undertaken a continuing study of the birth rate of college graduates. The study has confirmed earlier reports that the graduates of many American colleges are not reproducing themselves. It has established two other important facts: the alumni of some colleges are exceptions to this rule; and there is at present a clear trend toward a higher birth rate among college graduates generally.

As part of its expanded program the Bureau conducts a Population Information Service, this now being widely used by research groups, government and social agencies, congressional committees, other information services, and by the group mentioned above who read the *Population Bulletin*.

Looking to the future, the Bureau has recently turned its attention to the interested student in its effort to help develop that leadership which the younger generation will be called upon to give as population problems inevitably increase in momentum. A six-week workshop with a limited number of graduate students participating is the medium with which the Bureau has experimented during the past two summers. Each student completes a research project, participates in a series of seminar discussions which includes demographers, conservationists, and representatives of the press and radio, and assists in the preparation and editing of at least one issue of the *Bulletin*. The workshop has proved a successful technique, and it is hoped that it can be expanded in 1954.

ROBERT C. COOK

Population Reference Bureau
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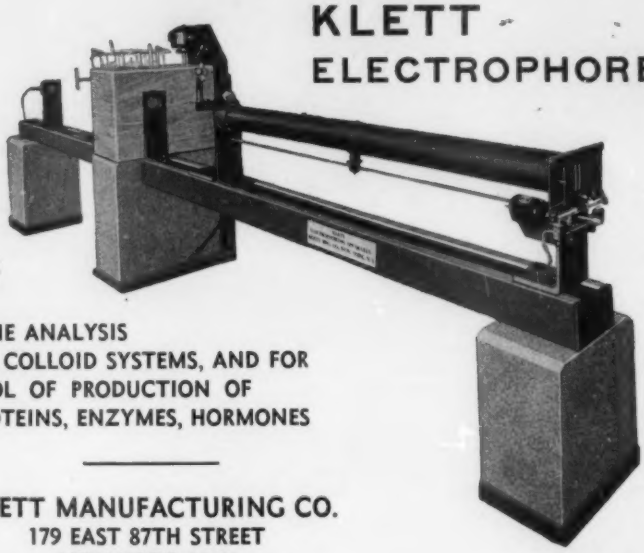

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Angular Correlation of Nuclear Radiations[1]

M. E. Rose

Oak Ridge National Laboratory, Oak Ridge, Tennessee

THE PROBLEMS OF NUCLEAR PHYSICS have been a major concern of physicists for at least two decades. In the concerted effort which has been brought to bear on these problems, the primary question has been concerned with nuclear structure. That is, how are we to understand the existence of the known stable nuclei with specified neutron and proton numbers, the occurrence of unstable nuclei with their various modes of spontaneous decay, and the rates of such decay processes? These questions, as well as many others concerned with the binding energies, or, more generally, with the energy levels of stable as well as unstable nuclei, could be understood (in principle) if we were in possession of all the facts concerning nuclear forces and had the means of applying this knowledge in a detailed solution of the problems of nuclear dynamics. During the past twenty years considerable progress has been made toward the solution of this difficult problem; but, in many important areas, our understanding is not only qualitative but, frankly speaking, rather crude. In part, the difficulty is that while the general principles of the dynamics are well known, sufficiently complete information concerning nuclear forces is not yet available.

In view of the formidable character of the problem with which the nuclear physicist is faced, it is understandable that considerable effort has been expended in recent years along the lines of a phenomenological approach. Short-circuiting the nuclear force problem, at least temporarily, one asks if a more or less simple model can be invented which will account for the experimental facts, or at least some features of them. This type of *ad hoc* attack has the virtue that (*a*) progress can be made, (*b*) a "set of rules" can be established whereby experimental results can be interpreted and our knowledge advanced, and (*c*) an insight into the nature of the operative forces can be gained.

Once a model has been postulated, its validity (or degree thereof) can be demonstrated only by comparison with experiment and this in itself is no trivial program. The example, *par excellence*, of such models is the so-called shell model (*1, 2*) which makes a specific assumption with regard to the dependence of the forces on the angular momenta of interacting particles (coupling scheme). From this deductions as to the angular momenta of ground and excited states, the occurrence of isomers (long-lived energy states), the systematics of beta-decay and many other aspects of nuclear structure can be made. However, to take the example of angular momentum values of nuclear energy levels, the deduction of these from experiment is by no means direct, and a considerable body of auxiliary theory must be developed for this purpose. We return to this question below.

The general objective to be considered now is the determination of the properties of nuclear levels and the investigation of dynamic characteristics of the radiations emitted when an unstable nucleus is formed. To take a simple example, Co^{59} irradiated in a pile provides radioactive Co^{60} by capturing a neutron and emitting γ-rays ($n-\gamma$ reaction). From the ground state, as well as from the first excited state electron emission (β^-) takes place, forming Ni^{60} in second and first excited states respectively. Stable Ni^{60}, in the ground state ensues by γ-emission. In the case of the 0.32-Mev β^--emission, there is a cascade of two γ-rays of energies 1.17 and 1.33 Mev in temporal order. Figure 1 shows the decay scheme for this chain of events.

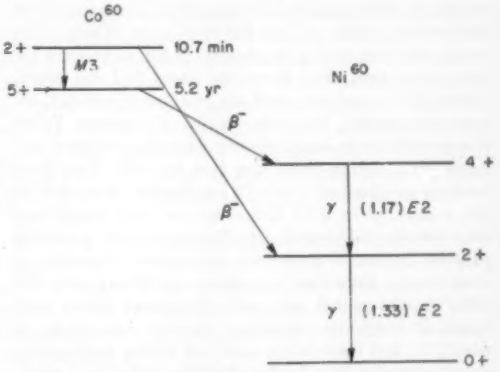

FIG. 1. Decay scheme of Co^{60}. The γ-ray energies in Mev are shown in parentheses (*3*).

The genealogy of the Co^{60} decay is established by β–γ coincidence studies (*3*). The angular momentum and parity[2] changes involved in the β-transitions are established from a study of the shapes of the β-spectra and the measured β-lifetimes. The angular momentum and parity change between the two lowest Co^{60} states

[1] A much more detailed and comprehensive survey of this subject appears in the article by L. C. Biedenharn and M. E. Rose, *Rev. Mod. Phys.*, **25**, 729 (1953). In that paper, which will be referred to as BR, numerical results as well as a complete quantitative account of the theory will be found. A much more complete list of references is also to be found in that survey article.

[2] Parity is a certain symmetry property of the wave function describing the nuclear state considered. The concept of parity has no classical analogy. The parity of a state is "even" if an inversion of all spatial coordinates does *not* change the sign of the associated wave function. When the inversion of the spatial coordinates in the wave function does change the sign, then the parity of the state is said to be "odd."

is determined by measuring the internal conversion coefficient (ratio of conversion electrons to γ-rays) emitted in this transition. The designation $M3$ in Fig. 1 means a magnetic octupole γ-ray. The angular momentum and parity of the Ni^{60} ground state is almost certainly 0^+, since without exception this is true of all nuclei with even numbers of protons (28 here) and neutrons (32 here). The remaining information (angular momentum and parity of the two excited states of Ni^{60}) can also be obtained by internal conversion and relative gamma intensity measurements. Internal conversion effects, however, are quite weak for these gamma rays, and lifetimes for γ-transitions are here too short to be measured. Consequently the independent determination of the angular momenta and the parities of the Ni^{60} states by angular correlation measurements is of major interest. This particularly straightforward case illustrates the fact that the unraveling of decay schemes involves the combined use of several kinds of experimental techniques and the pooling of information derived from all of them.[3] In very many cases the method of angular correlation measurements is the only way to determine angular momenta of nuclear states.

Description of the Angular Correlation Process

Whenever a nucleus in an unstable state emits two (or more) radiations in succession there is a possibility that the directions of emission are not randomly distributed with respect to each other but are *correlated* (*4*). Some angles θ between the two propagation vectors are more or less favored over others. This result will also apply, in general, if the radiations are not consecutive. Only in special cases will this correlation fail to appear, and all relative directions are equally probable. One then speaks of *isotropy*. When the correlation is isotropic one can often deduce valuable information from this fact as well. Two facts must be emphasized: (*a*) The radiations need not be two γ-rays, as in Ni^{60}. Either one or both transitions may involve emission of α-particles, β^+- or β^--particles, protons, neutrons, deuterons, conversion electrons, or even x-rays following conversion or K-capture. We refer in the sequel to a set of nuclear levels with specified properties (energy, angular momentum j, parity ±), but these levels need not belong to the same nuclear species. (*b*) In the above we refer to a correlation measurement in which the directions of emission of the two radiations are observed. This is the easiest measurement to make and, in a large number of cases, it suffices to provide all the information needed. However, in one important case, that is, γ-ray emission, the parity change is not fixed by the angular correlation observations. This information is provided by a so-called polarization-direction correlation measurement. This is discussed more completely later.

[3] Ni^{60} is also formed by the decay of Cu^{60} which emits positrons (β^+). In other cases there is appreciable competition between β^+-emission and the capture of orbital electrons (mainly from the K-shell). The measurement of the branching ratio, K-captures to β^+-emissions, is also useful in some cases.

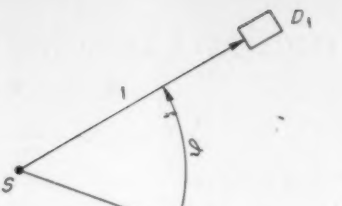

Fig. 2. Schematic angular correlation arrangement.

The experiment envisaged (*5*) is the measurement of the coincidence rate of two detectors, see Fig. 2, as a function of the angle θ. In most cases one can easily arrange matters so that one particular detector records only one of the two radiations, the other detector recording the other radiation (*6, 7*). When this is not convenient it is only necessary to consider the weighted average of the expected coincidence rate for radiation 1 to detector D_1 and radiation 2 to detector D_2 with the rate for the radiations interchanged. The weight factors are overall detector efficiencies which are easily measured.

It is important to understand why there should be an anisotropic correlation at all. For this purpose only very simple facts need be adduced. First, consider a single transition taking place from a level of angular momentum j to another of arbitrary angular momentum. All angular momenta and components are measured in units of $\hbar$ = Planck's action constant divided by 2π; i.e., $\hbar = 1.05 \times 10^{-27}$ erg sec. The first fact is that, as a consequence of space quantization of all angular momentum vectors, these vectors can assume only a finite number of orientations. For the initial level there are $2j+1$ orientations possible corresponding to the fact that the component of angular momentum in any[4] *one* direction can assume the values $m = -j, -j+1, \ldots j-1, j$. In the absence of magnetic fields (internal or external) and homogeneous electric fields, these $2j+1$ states are degenerate, that is, they have the same energy. Consequently all these states with different m are equally populated. The total intensity radiated in any direction is the sum due to transitions from the $2j+1$ substates and these enter with equal weights. As a consequence, one finds the expected result that the radiation is isotropic. On the other hand, if an external magnetic field were present the $2j+1$ substates would be no longer degenerate but would show a very small Zeeman splitting. The ensuing unequal populations distributed according to the Boltzmann law, would have the effect of introducing anisotropy (with respect to the magnetic field direction) because the unequal weights with which each substate enters would prevent the exact cancellation of anisotropic

[4] The direction is arbitrary because there is no physical distinction between various directions in the situation considered. Thus, in the absence of a magnetic field, which would make one direction preferred, space is isotropic.

contributions arising from each of these substates.

How then does anisotropy arise in a correlation of radiations in coincidence, even though there are no fields producing level splitting? The answer is that by selecting a specific direction for one of the radiations (say, the first) we select a particular subset of all possible transitions originating from the intermediate level (see Fig. 3). While all $2j+1$ substates are equally populated the transitions from the separate m values do not contribute equally. Selecting a direction for the first transition makes space anisotropic. In detail, suppose we consider two γ-rays emitted successively and further, suppose that $j_1=0$, $j=1$, $j_2=0$ in Fig. 3. The angular dependence of the intensity of γ-radiation from j_1 to j is:

$$I_{\pm 1}=\tfrac{1}{2}C(1+\cos^2\theta), \quad I_0=C\sin^2\theta \tag{1}$$

where the subscripts are the values of $\Delta m=m_1-m$ and here $m_1=0$. C is a constant and θ is the angle between the propagation vector of the first γ-ray and the axis of quantization-axis with respect to which m is measured. This axis can be taken arbitrarily. If it is taken along the direction of the first γ-ray, $\theta=0$ and only $I_{\pm 1}\neq 0$. The state $m=0$ is not populated at all so far as the experiment is concerned. Consequently, in the second transition only $\Delta m=\pm 1$ is possible and the correlation function giving the coincidence rate is proportional to $1+\cos^2\theta$ – anisotropic! This result can be expressed by the observation that a γ-ray can have components of angular momentum along its direction of propagation equal to ± 1 only. Similarly, for an α-particle only a zero component of angular momentum along the direction of motion is possible. In the above example the correlation for an $\alpha-\gamma$ or $\gamma-\alpha$ transition is proportional to $\sin^2\theta$. In all cases only the angular shape is important and proportionality constants are irrelevant.

The application of the data can now be seen. If one considers the scheme of Fig. 3 and the case of γ-rays emitted in both transitions as an example, the first transition will be a 2^{L_1} pole γ-ray, where L_1 is an integer between the limits $|j_1-j|$ and $|j_1+j|$ and the second will be a 2^{L_2} pole γ-ray, $|j_2+j|\geq L_2\geq|j_2-j|$. Because the radiation wavelength is always considerably larger than the size of the nucleus, usually the smallest L value ($L>0$) consistent with parity conservation will be important. This is the case of pure multipoles. It is possible that either or both transitions contain an admixture of the next higher pole (2^{L_1+1} and 2^{L_2+1}), where L_1 and L_2 are the minimum values. This will not occur unless both j's involved in the transition differ from zero. In any case, the theoretical evaluation of the correlation function will give a coincidence rate $W(\theta)$ of the form (*8–10*)

$$W(\theta)=\sum_{\nu=0}^{\nu_{max}}A_\nu P_\nu(\cos\theta) \tag{2}$$

where P_ν is a Legendre polynomial and the A_ν depend on j_1, j, j_2 and on L_1, L_2. In the mixed case A_ν will also contain the relative intensity of the 2^{L_1+1} to 2^{L_1} poles if, say, only the first γ-ray is mixed. In Eq. (2) ν is always an even integer and ν_{max} is the smallest of $2L_1$, $2L_2$ and $2j$. Since $P_0=1$, it follows that for $j=0$ or $j=\frac{1}{2}$ only isotropy results. This is obvious, at least in the $j=0$ case. In the case $j=\frac{1}{2}$ the isotropy is a consequence of the fact that there are only two substates, and the increase of population of one is equal to the depletion in the population of the other. The anisotropy results from an effective alignment of the nuclear spins in the *intermediate* level. That is, considering the substates of this level in the way they actually contribute, then the pertinent populations are not uniform. Since L_1 and $L_2\geq 1$ for γ-rays, the observation of isotropy tells us at once that $j=0$ (for even mass nuclei) and $j=\frac{1}{2}$ (for odd mass nuclei), provided there are no disturbing effects which wash out the angular correlation (see below). Otherwise when anisotropy occurs, and this is the more frequently occurring case, comparison of observed results and theory enables one to assign j-values to the nuclear levels and L-values to the radiation. Numerical values of A_ν for pure and mixed multipoles are given in BR. Comparison of these results with the observations (*5*) leads to the assignment shown in Fig. 1. Both Ni^{60} γ-rays are electric quadrupole radiations ($E2$).

In an $\alpha-\gamma$ or $\gamma-\alpha$ correlation, to take another example, the A_ν are different. In fact, isotropy here can occur for $L_\alpha=0$ ($j_1=j$ or $j=j_2$) which means that the α-particle has zero orbital angular momentum. The difference between the A_ν coefficients for the $\alpha-\gamma$ and $\gamma-\gamma$ cascades is

$$A_\nu(\alpha-\gamma)=b_\nu(\alpha)A_\nu(\gamma-\gamma) \tag{3}$$

where $b_\nu(\alpha)$ is a so-called particle parameter which depends on properties of the α-particle only and not on the nuclear properties like j_1, j, j_2. There is an indirect dependence on the parities of the nuclear states in that between two states with the same parity, parity change "no," only α-particles with even L can be emitted and for parity change "yes," only α-particles with odd L are possible. In general, for a transition $j_1\rightarrow j$, the possible L values are $|j_1-j|\leq L\leq|j_1+j|$ and for α-particles only every other value is permitted because of the parity conservation. In many cases the barrier due to centrifugal forces depresses the contri-

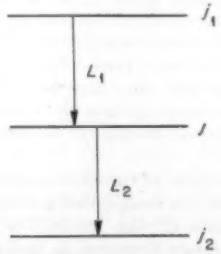

FIG. 3. Level diagram for angular correlation of successive radiations. The three levels are $2j_1+1$, $2j+1$, $2j_2+1$-fold degenerate, reading from top to bottom. The symbols L_1 and L_2 refer to the angular momentum of the emitted radiations.

butions of all but lowest possible L value. In this case we have a situation analogous to the pure multipole γ-ray case. For α-particles with a pure L the parameter $b_\nu(\alpha)$ depends only on ν and L and not on the α-particle energy or other nuclear properties.

The results expressed by Eq. (3) is a special case of a general rule (*10–12*). A standard correlation, such as the $\gamma-\gamma$, can be adopted. Then all correlation functions are of the form Eq. (2) and if the radiations are generally labeled x and y

$$A_\nu(x-y) = b_\nu(x) b_\nu(y)\, A_\nu(\gamma-\gamma) \qquad (4)$$

where the particle parameters $b\nu(x)$ depend only on the properties of the radiation x and A_ν contains all the dependence on nuclear j-values. The introduction of these particle parameters greatly simplifies the theory and the presentation of the results, see BR.[5] It also enables one to view the angular correlation process from a simple point of view in that part of the theory which is concerned with the properties of angular momentum and this is the same no matter what kind of radiations are emitted as long as they carry given amounts of such angular momentum. This part is expressed essentially by the coefficients A_ν. The remainder of the considerations pertinent here is the physics of the radiations. For example, this involves the potential field in which a K-electron moves in the internal conversion process (*11*). All such factors, depending on a physical model, are contained in the b_ν. In particular, for the $\beta-\gamma$ or $\beta-\alpha$ (in fact $\beta-x$) correlations, the b_ν depend not only on the energy of the β-particle and the Coulomb field in which it moves but also on the form of the β-decay theory and on quantities (nuclear matrix elements) whose values are dependent on the details of nuclear forces. When the form of the β-decay theory is firmly established by purely β-spectroscopic experiments, the correlation involving β-transitions would be useful for the purpose of fixing the values of these nuclear matrix elements and hence obtaining a clue as to the fine points of nuclear structure.

Other applications of angular correlation observations are considered later. At this juncture it suffices to say that, except in the case of γ-ray emission, a parity change determination is also provided by the angular correlation measurements and the analysis thereof. As mentioned, the directional correlation with α-particles fixes L, the α-particle orbital angular momentum, and the parity change is $\Delta\pi = (-)^L$ where $\Delta\pi$ is the product of parities of the initial and final states of the transition (+1 for even or symmetrical states, −1 for odd or antisymmetrical states). This statement is also true for any particle which can be treated nonrelativistically, in which case intrinsic spin effects do not enter. Thus, it applies for neutrons, protons, deuterons, etc. But for conversion electrons and β-particles, which must be treated relativistically, the parity change cannot be expressed in such a simple way. Nevertheless, the correlation processes involving such particles do depend on the parity changes involved in the corresponding transitions. This is clear when it is noted that for conversion electrons, the total intensity, or alternatively the internal conversion coefficient, is strongly parity-change dependent (*11, 13*). The nucleus, regarded as an electric dipole (of dynamic character) has a different probability for ejecting orbital electrons than a nucleus which behaves like an oscillating current loop (magnetic dipole). For β-transitions the shape of the energy spectrum of the β^+ or β^- is parity dependent and the β-decay lifetime is strongly so. In fact, for conversion electrons and β-particles parity determinations are usually more convenient by total intensity measurements.

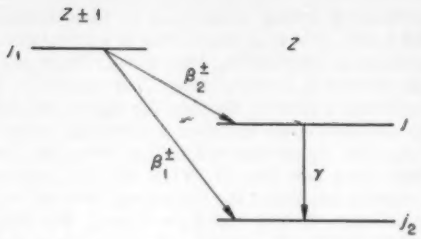

FIG. 4. Decay scheme showing a β-branching. The allowed shape occurs for β_2 if $|j_1 - j| = 0$ or 1 and the parities of these levels are the same.

This brings the discussion to the question of the relative advantage of correlation measurements over other procedures for obtaining the same information. With regard to directional $\gamma-\gamma$ correlations the information provided (L and j values) is also obtainable from separate internal conversion measurements for each transition. Aside from the fact that an angular correlation provides information about both transitions (three levels) in one experiment, there is also the important factor that both for low atomic numbers (Z less than about 20) and high transition energy (E greater than about 2 Mev) internal conversion becomes a rather weak effect. On the other hand, $\gamma-\gamma$ correlations are not affected by either of these two considerations. The coefficients A_ν $(\gamma-\gamma)$ are neither Z nor E dependent. On the other hand, we shall later discuss an important effect which causes some trouble in the interpretation of all correlation measurements but does not affect total intensity measurements. However, as will be evident, these effects are of considerable interest in that they may provide a means of studying some very interesting extranuclear phenomena which would be difficult to investigate in any other way.

Another advantage of correlation measurements can be illustrated by the simple decay scheme of Fig. 4. The excited state of the nucleus of charge $Z \pm 1$ branches, giving two β groups, β_1 and β_2. Unless the lower energy group β_2 is very much more intense than β_1 the shape of the β_2-spectrum would be difficult to measure in the presence of β_1. However, a $\beta_2-\gamma$ cor-

[5] The only important cases where the codification expressed by Eq. (4) is not applicable is in the case of neutron or proton emission (or absorption). In this case one pair of j-values differs by $n + \frac{1}{2}$ where n is an integer while in the γ-ray case the difference is always an integer.

relation is unaffected by the presence of β_1 and this provides the same (and, in fact, additional) information. If β_2 has an "allowed" shape, which occurs, for example, if in the β-transition $\Delta j = 0, \pm 1$ and $\Delta\pi = 1$, the angular correlation will be isotropic. In measuring the β-spectrum there are always instrumental deviations at low energies from the theoretically permitted shapes of the β-spectrum due to backing and source thickness distortion. This need not be a source of difficulty in the correlation measurement because it is permissible, and moreover advisable, to use pulse height discrimination in such a way that only the higher energy β-particles are accepted. If one accepts the low energy β-particles the correlation tends to be more isotropic. This is because the low energy β-particles carry essentially zero orbital angular momentum and the direction of motion of such particles is not defined.

Additional Applications of Correlation Processes

Polarization-Direction Correlations. In the foregoing mention was made of the fact that the directional $\gamma-\gamma$ cascade provides no parity-change information. The reason for this is to be found in classical terms. An electric multipole wave is one with no radial component of magnetic field strength. It is a TM wave in another terminology. A magnetic multipole wave has a zero radial component of electric field strength. It is a TE wave. In fact these two waves are dual to each other; namely, aside from constant multiplicative factors of no importance here, the electric and magnetic fields, **E** and **H** respectively, of one are obtained from the other by the duality transformation

$$\mathbf{E} \rightarrow \mathbf{H}, \qquad \mathbf{H} \rightarrow -\mathbf{E}$$

Now the Poynting flux ($\sim \mathbf{E} \times \mathbf{H}$) is unchanged by this. Hence electric and magnetic multipoles of the same angular momentum have the same Poynting flux, and hence the same intensity, at all angles.

The above statement applies only to unpolarized waves. Hence, if the polarization of one of the γ-rays is measured, as well as its direction, one can expect to find the parity change involved in the transition in which this γ-ray was emitted (*14*).

The arrangement, originally used by Metzger and Deutsch (*15*) is schematically shown in Fig. 5. Here the polarization sensitive detector is a Compton scatterer C and an ordinary (scintillation crystal) detector D_1 for the Compton scattered radiation. The other detector D_2 is as before. The angle θ is as defined above and ϕ is the angle between the electric field vector of the γ-ray going to the polarization-sensitive detector and the normal (n) to the plane containing the two γ-ray directions from the source S. One measures the number of triple coincidences in which one γ goes to D_2 and the other to C and D_1 as a function of ϕ. The theory gives a correlation function

$$W_1(\theta\phi) = \sum_\nu A_\nu P_\nu(\theta, \varphi) \tag{5}$$

where A_ν is as before and

$$P_\nu(\theta, \phi) = P_\nu(\cos\theta) + a_\nu(-)^{\sigma_1}\cos 2\phi P_\nu^2(\cos\theta) \tag{6}$$

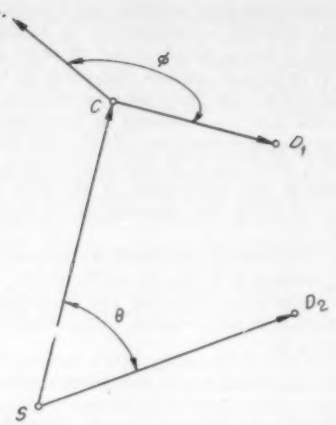

Fig. 5. Schematic diagram for polarization-direction correlation.

Here $\sigma = 0$ for electric and 1 for magnetic radiation and the parity dependence enters through the factor $(-)^{\sigma_1}$. The subscript 1 implies that it is the electric or magnetic character of the first photon which is pertinent. In Eq. (6)

$$P_\nu^2(\cos\theta) = \sin^2\theta \frac{d^2P_\nu}{d\cos\theta^2} \tag{7}$$

is the usual associated Legendre polynomial and a_ν depends on L_1, see BR. Pure multipoles are assumed for the sake of discussion.

One can expect that the second photon will also go to the polarization-sensitive detector ($C - D_1$), the first to the polarization-insensitive one (D_2). The correlation function for this is obtained by replacing σ_1 by σ_2 and L_1 by L_2 in a_ν. Let this correlation function be denoted by $W_2(\theta, \phi)$. If the overall efficiencies for the W_1 and W_2 arrangements are η_{12} and η_{21} then the measured quantity is

$$W = \eta_{12}W_1 + \eta_{21}W_2 \tag{8}$$

These results provide the basis for the interpretation of all experiments with pure multipoles. If there are mixtures present the correlation function is somewhat more complicated but has the essential properties of that given above, see BR. In general it suffices to make measurements at $\phi = 0$ and $\phi = \pi/2$. If the coincidence rates in these two positions are denoted by $W_\parallel$ and $W_\perp$, it is possible to deduce information concerning relative parities from the *sign* of $(W_\parallel/W_\perp) - 1$. In particular, for transitions with $L_1 = 1$, $L_2 = 2$, or $L_1 = 2$, $L_2 = 1$ with $\sigma_1 = \sigma_2$ and for $L_1 = L_2$ but $\sigma_1 \neq \sigma_2$ it is possible to determine both parity changes simply by measurements of the above-mentioned sign and that of $[W(\pi)/W(\pi/2)] - 1$, which is referred to as the anisotropy in the directional correlation. This is also possible in the case $L_1 = 1$, $L_2 = 2$ or $L_1 = 2$, $L_2 = 1$ but with $\sigma_1 \neq \sigma_2$ and $L_1 = L_2$ with $\sigma_1 = \sigma_2$. These are all very frequently occurring cases.

Correlation of Nonconsecutive Radiations. Many

decay schemes are quite complex, and it is not unusual that great difficulty is encountered in fitting the observed γ-rays into a proper order. If there are three (or more) γ-rays in cascade, the order of these can be determined by measuring their correlations in pairs. Thus, if the γ-rays are denoted by their energies E_1, E_2, E_3 one measures the three correlations $W(E_1 E_2)$, $W(E_2 E_3)$, $W(E_3 E_1)$. In this connection it is to be noted that in any correlation, if the time order of events is reversed, the correlation function is unchanged.

If, for the sake of argument, we assume that the order of emission is E_1, E_2, E_3 or E_3, E_2, E_1, then the first two correlation functions are described by the theory outlined in the preceding section while the third one is given by

$$W(E_3 E_1) = \sum_{\nu=0}^{\nu_{max}} B_\nu P_\nu(\cos\theta). \qquad (9)$$

The coefficients B_ν, different from A_ν, depend on three L values and four j-values. They are given in BR. There is an extra limitation on ν_{max}; that is, ν_{max} is the smaller of the four integers $2L_1$, $2L_2$, $2j$, $2j'$, where L_1 and L_3 refer to the observed (first and third) γ-rays, j and j' are the momenta of the two intermediate states, see Fig. 6.

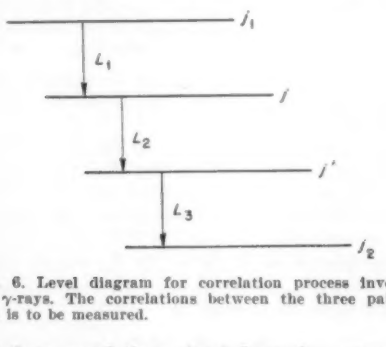

FIG. 6. Level diagram for correlation process involving three γ-rays. The correlations between the three pairs of γ-rays is to be measured.

All three correlations give information concerning at least some of the three L's and four j's and the information from each experiment overlaps. In general, only when one assigns the order of the γ-rays correctly will this overlapping information be free of contradiction.

Another possible application of the measurement to which Eq. (9) would apply, arises when the intermediate (unobserved) γ-ray is of such low energy and low intensity that its observation would be very difficult.

Measurement of Magnetic Moments of Excited States. It has been emphasized that the correlation depends in a vital way on the fact that the populations of the substates of the intermediate level were nonuniform. Clearly any type of extranuclear field which can cause transitions between these substates will alter the correlation function (*16*). If the strength and direction of this external field is given, the observed alteration of the correlation provides information concerning those parameters of the nucleus which measure the amount of interaction or coupling energy to the field. Now, it was seen that for an anisotropic correlation $j \geq 1$, and this means that in the intermediate state the nucleus will, in general, have both a magnetic dipole and electric quadrupole moment. Higher moments (magnetic octupole, etc.) could exist if $j \geq 3/2$, but are far too small to give rise to observable effects. For historical reasons we confine our attention to coupling to the magnetic dipole moment, and this implies a comparison of the correlation with and without an external magnetic field.

It is important in such an experiment that only the external magnetic field acts. Otherwise one has a hopeless tangle of effects of a quadrupole moment coupled to an inhomogeneous electric field and/or the coupling to an essentially unknown magnetic field of variable direction arising from the magnetic moment of electrons in the immediate vicinity of the nucleus. These effects can be made negligible in a manner to be described in the following section.

Whatever the nature of the coupling, two things are clear. First, the coupling will split the levels and there will be a characteristic frequency whose magnitude is a measure of this splitting. In the case of the magnetic field this is the well-known Larmor frequency

$$\omega = \frac{\mu H}{j\hbar} \qquad (10)$$

where μ is the nuclear magnetic moment of the state j. In the magnetic field **H**, the nuclear angular momentum j precesses with this frequency. If the mean life of the intermediate state is τ, the number of radians through which the precession progresses is ωτ. Unless this is comparable to unity the effect will be too small to detect. On the other hand $\omega\tau \gg 1$ is undesirable since this will give isotropy. Since $\mu \sim 10^{-23}$ cgs, this implies $\tau \sim 10^{-8}$ sec for $\mathbf{H} \sim 5000$ gauss. This is just in the range of many dipole and quadrupole γ-rays. For high-energy dipole and quadrupole radiations for which τ is less than about 10^{-12} sec the requisite field strength is too large. Moreover, a measurement of τ in this range is not feasible at present. For slower transitions (τ greater than about 10^{-4} sec) other difficulties arise.

The second fact, which emerges clearly, is that any coupling to the nuclear spin will attenuate, that is, "wash out" the correlation so that the anisotropy will tend to disappear. This comes about because precessions, or more exactly transitions between different substates will proceed most rapidly from rich populated to poorly populated substates. Hence, in certain cases, if allowed to proceed long enough the system saturates when the populations are equal. For this reason τ must not be too large.

Because there are now three directions specified, the magnetic field direction and that of the two γ-rays, the correlation function takes on a somewhat more complex form than Eq. (1). However, a practical arrangement is one in which the magnetic field is perpendicular to the plane of the two γ-rays (12). Then

$$W(\theta) = \sum_{\nu=0}^{\nu_{max}} \frac{S_\nu}{1+(\nu\omega\tau)^2} \cos\nu\theta \qquad (11)$$

where S_ν are the coefficients without magnetic field and are simply related to the A_ν of Eq. (1). Equation (11) shows that isotropy results for large $\omega\tau$.

It is clear that a comparison of anisotropies gives $\omega\tau$ and a life-time measurement gives τ. Since j is known from the usual directional correlation in zero field the magnetic moment μ in the intermediate state can be measured. Since only ω^2 enters it appears that only the magnitude of the magnetic moment can be measured. However, Eq. (11) refers to the case that the overall efficiencies of the detectors is the same when the photon directions are interchanged. It is clear that interchange of photon directions is equivalent to reversing the direction of the magnetic field. Therefore, with unequal efficiencies (using energy discrimination) one can also measure the sign of μ.

While other means for obtaining this information have been developed recently, using polarized nuclei at low temperature, the procedure described here has some obvious advantages. It has been carried out successfully in one case thus far (*17, 18*).

Very recently attenuation effects of the quadrupolar coupling in single crystals have been discovered (*19*). It must be recognized, however, that here one starts with an additional unknown factor. The inhomogeneous electric field is not a "synthetic" one and its properties are not specified a priori.

Spin Coupling in Angular Correlation

The use of a magnetic field as just described constitutes what might be called a beneficial effect of spin-coupling. As already intimated it may be that other couplings due to fields whose properties are not so well known are also present. Moreover, these fields cannot be turned off in any obvious way. They arise from magnetic interactions, which are also manifested by hyperfine structure, and from quadrupole interactions.

Let us consider a nuclear cascade initiated by K-capture. Before the K-capture takes place one may assume, for the sake of simplicity, that the electronic environment possesses no magnetic moment. In this state no magnetic interaction occurs. However, the K-capture results in a K-vacancy. In a time of order 10^{-14} sec this will be filled by x-ray emission or Auger transitions, thus removing the hole to outer orbits, and to some extent, producing new holes. The K-capture is followed by a cascade of two γ-rays or other radiations.

We further assume that the ion is embedded in an environment in which, by some process involving electron transitions, the ground state with zero coupling can be reestablished. There will be a characteristic relaxation time τ_{el} for this process. Then one of several possibilities may apply:

1) The lifetime τ_1 in the initial (j_1) nuclear state is long compared to τ_{el}. Then if the first radiation does not produce any appreciable disturbance in the electronic environment, the intermediate state is established without spin-coupling and the theory described above for an isolated nucleus applies. If by recoil or sudden charge change, the first radiation excites or ejects an electron the intermediate state is subject to spin coupling.

2) If the spin-coupling attenuation is operative in the intermediate state, the effect will be large or small according as to whether τ is about equal to or greater than about τ_{sp} or $\tau \ll \tau_{sp}$. Here τ is the intermediate state mean life and τ_{sp} is the precession period ($\sim 1/\omega$).

3) If $\tau_{el} \ll \tau$ the ion will "heal" rapidly, but for no appreciable attenuation it is necessary that $\tau_{sp} \gg \tau_{el}$ as well.

It is clear that what is going on is a series of complex electronic transitions which are concomitant with and strongly conditioned by the nuclear transitions. Everything depends on a comparison of τ_{el}, τ, and τ_{sp} in the intermediate state. The first is a function of only the electronic environment, the second is essentially a purely nuclear property, and the third is a property of the coupling between nucleus and environment. This strong interplay of nuclear and non-nuclear phenomena is due to two facts. First, we are dealing with an angular distribution. In contrast, if we require a knowledge of the total number of transitions regardless of which substate of the intermediate level was involved, the precession of the angular momentum j is irrelevant. Hence total intensity measurements are free of these effects. Second, the nuclear lifetimes are often of the same order of magnitude as the time constants for the coupling and extranuclear processes.

From the viewpoint of the nuclear physicist there are two ways to treat the situation in which spin-coupling modifies the correlation. First, one may attempt to include it in the calculations. Secondly, one may attempt to remove spin-coupling or minimize its effects. These effects are often too small to be important, and even where they are observable they may not becloud the issue entirely because the experimental results are to be compared with a finite number (often a small number) of distinct possible theoretical curves. However, in a second class of correlations the degree of spin-coupling is too large to ignore.

The first possible course, wherein spin-coupling effects are calculated, can be carried out only if one assumes that the electrons remain in a fixed state. Then, as is expected, the correlation function assumes the form

$$W = \sum_{\nu=0}^{\nu_{max}} Q_\nu A_\nu P_\nu(\cos\theta) \qquad (12)$$

where Q_ν are the attenuation coefficients. Of course, $Q_0 = 1$ and $0 < Q \leqslant 1$. They depend only on parameters describing the physical situation in the intermediate state. Thus, for magnetic interactions Q_ν depends on τ, j, μ, ν, and on H_{eff} where the latter is the effective magnetic field produced by the environment. This latter, unfortunately, is not known but an empirical

set of attenuation coefficients may be determined from comparison of (12) with the data and the ν-dependence of these compared with what is expected.

It is of interest to note that the same attenuation factors Q_ν apply whatever the nature of the radiations and whatever the nature of the observations made on the radiations. Thus, in the polarization-direction correlations the A_ν are replaced by $Q_\nu A_\nu$ as above. It can be shown quite easily that, to a large extent, conclusions concerning parity changes as deduced from polarization correlation measurements are independent of the precise form of the coefficients A_ν. Thus, if the experimental coefficients are used here spin-coupling is automatically taken into account in a correct manner. This fact that the attenuation is independent of the nature of the radiations or observations made is understandable since, for given spin-coupling, it does not matter how the intermediate state is reached.

As to the second possible course, two procedures to remove spin-coupling effects have been developed. The first involves the use of thin evaporated or electrodeposited metallic films. This method has been more or less outmoded by the second, which involves the use of dilute aqueous solutions. However, since some interesting solid state phenomena are involved in the thin film method, a few words regarding it may be in order. The method was developed and used mainly by the Swiss group of experimenters (*20*). By using an In^{111} source (decaying to Cd^{111}) the In^{111} ions were embedded in a thin metallic film by evaporation of both the In and the metal from two sources. Oddly enough it was found that most metallic environments did not give the maximum anisotropy, corresponding to no spin coupling, but only Ag worked well. The results depended on the film thickness (of order 10^3–10^4 A), the nature of the backing, temperature, and rate of evaporation or electrodeposition. For the most part the pertinent properties of such films have not been studied. The angular correlation is very sensitive to the various properties listed above, and the results could presumably shed some light on the structure of such thin layers.

With regard to the dilute solution sources (*21–23*) it is clear that one once again is confronted with a physical problem of which little is known. The evidence that dry sources of a large variety of compounds give a diminished anisotropy and that dilute solutions of these same sources uniformly exhibit a maximum correlation is now quite convincing (*21, 22*).

In a liquid one would expect a fairly homogeneous environment. Due to the averaging effect of the Brownian motion there should be only small magnetic fields and inhomogeneous electric fields, if any at all. That residual small quadrupolar couplings may exist seems to be rather plausible, and the possibility of studying these, using angular correlations measurements as a tool, has recently opened up.

It should be noticed that the use of dilute solutions would make correlation measurements with charged particles (conversion electrons and β-particles) impossible. The amount of liquid is necessarily such that a large amount of scattering will occur. On the other hand, by using a dry thin source for which the scattering is such that corrections can easily be made, one can eliminate attenuation effects by comparing two cascades γ − γ and γ-conversion electron. The intermediate state is the same in these two cases so that the Q cancel out in the ratios of experimental coefficients. However, this procedure cannot apply to β-particles. It is also clear that correlation measurements in which the β-particle is emitted as a second radiation are not feasible. This follows since β-emitting states are long-lived and all types of weak spin-coupling would then play a role.

In addition to scattering corrections for electrons or positrons, corrections for the finite solid angle subtended by the detectors are also important. Both of these introduce attenuation (or "smearing") factors so that experimentally Q_ν may be the product of as many as three factors. Of course, for scattering the attenuation factors depend on the nature of the particle since they involve the scattering properties. The finite solid angle corrections are geometrical and in addition depend on detector efficiency as a function of position in the detector.

In summary, it may be said that the study of angular correlation processes has already been demonstrated to be one of the more valuable tools in the attack on the problems of nuclear structure. This is based in no small measure on the circumstance that the theory rests on as firm a foundation as any modern development in physics. For the rest, the utilization of this tool has been made possible by the very gratifying development in detecting techniques which has taken place in recent years.

References

1. Mayer, M. G. *Phys. Rev.*, **78**, 16, 22 (1950).
2. Haxel, Jensen, and Suess. *Z. Physik*, **128**, 301 (1950).
3. Goldhaber, M., and Hill, R. D. *Revs. Modern Phys.*, **24**, 179 (1952).
4. Hamilton, D. R. *Phys. Rev.*, **58**, 122 (1940).
5. Brady, E. L., and Deutsch, M. *Ibid.*, **78**, 558 (1950).
6. McGowan, F., Klema, E., and Bell, R. P. *Ibid.*, **85**, 152 (1952).
7. *Ibid.*, **86**, 413 (1952).
8. Gardner, T. W. *Proc. Phys. Soc. (London)*, **A62**, 763 (1949).
9. Lloyd, S. P. *Phys. Rev.*, **80**, 118 (1950).
10. ———. The Angular Correlation of Successive Nuclear Radiations. Doctoral thesis, Univ. of Illinois (1951).
11. Rose, M. E., Biedenharn, L. C., and Arfken, G. B. *Phys. Rev.*, **85**, 5 (1952).
12. Alder, K. *Helv. Physica Acta*, **25**, 235 (1952).
13. Rose, M. E., *et al. Phys. Rev.*, **83**, 79 (1951).
14. Hamilton, D. R. *Ibid.*, **74**, 782 (1948).
15. Metzger, F., and Deutsch, M. *Ibid.*, **78**, 551 (1950).
16. Goertzel, G. *Ibid.*, **70**, 897 (1946).
17. Aeppli, H., *et al. Ibid.*, **84**, 370 (1951).
18. ———. *Helv. Physica Acta*, **25**, 339 (1952).
19. Albers-Schönberg, H., *et al. Phys. Rev.*, **90**, 322 (1953).
20. Frauenfelder, H. *Ibid.*, **82**, 549 (1951); Aeppli, H., *et al. Ibid.*, **82**, 550 (1951).
21. Kluyver, T. C., and Deutsch, M. *Ibid.*, **87**, 203 (1952).
22. Steffen, R. M. *Ibid.*, **89**, 903; **90**, 1119 (1953).
23. Abragam, A., and Pound, R. V. To be published in *Phys. Rev.*

News and Notes

The AIBS Meeting

FROM September 6 to 10, 1953, most of the member societies of the American Institute of Biological Sciences held their annual meetings on the campus of the University of Wisconsin. This was the fourth time in as many years that the AIBS has held a large campus meeting in September, an event that has become as characteristic of the AIBS as the Christmas meetings are of the AAAS.

The recent Wisconsin meetings were predominantly botanical, the majority of the 2700 registrants having come to attend the meetings of the Botanical Society of America, the American Phytopathological Society, the American Society for Horticultural Science, the American Society of Plant Physiologists, and the Mycological Society of America. Not all of the societies meeting at Madison were members of the AIBS; some were affiliates, others had not yet become formally connected with the Institute. For example, other botanical societies meeting with the AIBS were the American Bryological Society and the American Society of Plant Taxonomists (members), the Potato Association of America and the Society for Industrial Microbiology (affiliates), and the American Fern Society and the Phycological Society of America (not affiliated). Still other societies having an interest in the animal sciences in varying degrees, held meetings at Madison: The American Society of Parasitologists, the Society of Protozoologists, the American Microscopical Society, the American Society of Limnology and Oceanography, the Biometric Society (ENAR), the Ecological Society of America, the Society for the Study of Evolution, and the National Association of Biology Teachers. Also participating in the meetings were Sigma Xi and Sigma Delta Epsilon.

Attendance at any national scientific meeting from a given state is directly proportional to the scientific population of the state and inversely proportional to its distance from the meetings. It might have been predicted that Wisconsin would be followed by New York and Illinois in attendance and that declining attendance figures would follow from Michigan, Ohio, Minnesota, Maryland, California, and Iowa. Held as they are in the academic vacation month of September, the AIBS meetings cater especially to biology teachers. It was estimated that 72 per cent of the registrants at the Wisconsin meetings hold positions in academic institutions. Many came by automobile and brought their families. They looked and acted as if they were on vacation. They filed up to the registration desk wearing comfortable field clothes, and when they received their housing assignments in one of the dormitories they settled down as informally as if they were staying at a tourist court. The weather and the environment favored a comfortable relaxed approach to the business of the occasion. When the meeting of old friends and new acquaintances became physically tiring, they could retreat to chairs on the shore of Lake Mendota and yield themselves to the fascination of the blue sky and water, white clouds, and sails.

In his "Contributions from the Captive Audience" (*AIBS Bull.*, July 1953, p. 24), Russell B. Stevens called for a "smoker on the night preceding the first full day of the affair . . ." This was arranged in the form of a welcoming tea sponsored by Sigma Delta Epsilon and AIBS and held on Sunday afternoon in the Great Hall of the Union. President Fred and other officials of the University were present to greet the incoming guests. The traditional Biologists' Smoker was held on Wednesday night in the Rathskeller of the Union where more than twenty exhibitors' booths were displaying biological books and equipment. The crowd eddied through the vaulted room, in and out of exhibitors' booths, back and forth upon the lighted lakefront terrace, past the refreshment stands, around and around, happily jostling one another and filling all available space.

There were more serious general affairs, of course, than the social whirls. T. C. Byerly, chairman of the AIBS, presided at the General Meeting held on Monday evening in the Union Theater. Here President Fred gave his address of welcome. The principal scientific address was then delivered by E. J. Kraus on the "Significance of Growth-Regulating Substances in Agricultural Practice." This scholarly review by a pioneer in this field was sponsored by Sigma Xi and AIBS and was regarded as a birthday message to the American Society for Horticultural Science, then celebrating its Fiftieth Anniversary.

Each of the societies meeting at Madison had some special events of its own: a breakfast, luncheon, or dinner; a foray, field trip, or excursion; a symposium or colloquium. There were also symposia of interest to more than one society, such as the symposium sponsored by the Society for Industrial Microbiology, on "Biology and Industry," and that of the American Phytopathological Society on "Cooperative Agricultural Research in the Western Hemisphere."

The real substance of the meetings consisted of 1140 contributed papers, each bringing its author to the attention of his colleagues and adding something to the structure of biological science. Which papers were most significant and stimulating can be determined only by those specialists who heard them. The papers that had some bearing on human affairs were brought to the attention of the press by the efficient University of Wisconsin News Service.

For all scheduled papers and events not mentioned above, the reader should consult the *AIBS Bull.*, Aug., 1953. Unscheduled events are likely to remain longest in the minds of those who were present—a profitable contact made at the AIBS Placement Service, an old friend seen again after a lapse of many years, unusual experimental material, instrumentation or data seen

during a visit to a colleague's laboratory, a view of the lake at sunset. Surely this is recreation!

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Science News

Because of the great importance of the matter to the nation, and in particular to all scientists, the following editorial on **manpower resources** from *Chemical and Engineering News*, Oct. 19, 1953, is reprinted in its entirety:

Arthur S. Flemming, director of Defense Mobilization, has appointed a 24-man Advisory Committee on Manpower Resources for National Security to help him prepare a report on the extent to which military manpower procurement policies and procedures have an impact on the availability of manpower for other national security needs.

The report will deal also with the availability of manpower to operate a national security training program while at the same time supplying military personnel for active service and meeting the needs of the civilian economy. The committee is to assess the resources of and requirements for manpower under current conditions and as they would be under stepped-up as well as full mobilization. Special attention, we are assured, will be given to manpower requirements for agricultural, scientific, professional, technical, and skilled personnel.

We are strong for facts, of course, but we wonder frankly what facts there are about the manpower problem not already known—that have not been known for several years.

Action is what we need desperately. We need an aroused public that will demand that Congress stop the military from trying to run the manpower show on an exclusively school-tie basis and without proper civilian representation.

We need an educated public that will demand the word "selective" really mean something in the interpretation and administration of the Selective Service Act by local draft boards, even if this means rewriting the Act, although we are by no means completely convinced such action is necessary.

We need top administration officials, including the President, who will take the facts we already know and with them as a guide develop a really intelligent and realistic manpower program—not one based on political expediencies, nor one dictated solely by the wishes of the military.

We need administration officials, Senators and Congressmen who boldly will support S.1551 and H.R.3893 —identical bills having the purpose of amending the Armed Forces Reserve Act of 1952 to include a National Manpower Board under the President, such board to consist of both civilian and military members familiar with the functions of specialized personnel.

The proposed amendment would prevent a National Manpower Board from being dominated by the military. The amendment would authorize a nine-man board but only three members would come from the Armed Forces on active duty, regular or reserve. This proposal is opposed by the military.

The new committee can perform a very worthwhile service if after whatever study it feels is necessary it does decide to recommend strongly that S.1551 and H.R.3893 be passed. Dr. Flemming, head of ODM, likewise can perform a great public service if he will actively support the idea of a National Manpower Board.

It should soon be evident whether the new committee is simply going to chew on an old cud or if its influence is going to be felt constructively here in Washington. If it is to be largely window-dressing for UMT, then the valuable time of important men is about to be wasted.

Frankly, we are disappointed that a number of individuals long associated with the manpower problem and well-known and respected for their intimate knowledge of the subject were not asked to serve on the committee. These are men who already have the facts and know what remedial steps are necessary.

If no constructive *actions* follow the findings of this latest group to probe into our manpower problem, then we will have made no progress whatsoever in preparing to meet a manpower situation that is serious today but which would be desperate if World War III erupts. We will be back where we were some years ago when the committee appointed by President Truman and headed by Charles A. Thomas, Chairman of the ACS Board of Directors, made substantially the recommendations now embodied in S.1551 and H.R.3893. We will have assembled a lot of facts but will have done nothing of a practical nature to solve what admittedly is one of the knottiest problems this country faces.

Official announcement of plans for the first day-by-day use of an electronic computer in a trial run on **weather forecasting** is expected in 1954. The experimental program, expected eventually to give much more accurate weather forecasts, will be run jointly by the Navy, Air Force, and Weather Bureau. Using electronic computers is a revolutionary method in numerical weather prediction, pioneered at the Institute for Advanced Study, Princeton, N. J. The system is so new that there are comparatively few experts on it in the world, yet it is so promising that government weather officials have completed plans for its trial, and need only the necessary funds to start the program. During its operations, the computer will be fed information on air pressures at several levels in the atmosphere, from near the ground to about 30,000 feet. It will then perform mathematical calculations on this information and come up, within an hour, with the figures from which nation-wide upper wind charts can be drawn.

These wind charts, needed in predicting weather patterns over the entire country, will then be sent to local forecasters. With this nation-wide picture as a background, the weathermen will then apply their specialized knowledge of local weather conditions to make their 24-hour prediction. The importance of these winds is emphasized by the statement from the Weather Bureau that the recent unexpected snow storm that blanketed the Northeast failed to be predicted because of lack of knowledge of the upper winds.

In the trial run with an electronic computer for making the wind charts, most, if not all, of the fore-

caster's subjective judgements concerning winds will be eliminated, although he will still have to make subjective decisions to go from the wind charts to actual weather forecasts.

At present, numerical forecasting proceeds as follows: Information on current weather conditions across the country is fed into the computer. Stored in the computer's "memory," are certain mathematical formulas describing the motions of great air masses. Using these formulas, the "brain" computes the winds one hour in the future. Then, working in one-hour jumps, these forecasts are repeated until finally a picture of the winds 24 hours in advance of the "present" is obtained. One computer can perform the millions of steps necessary to make such a 24-hour prediction in somewhat less than an hour.

With the use of formulas not now completely worked out, which would take into account such energy sources as variations in the heat received from the sun and those that result from water evaporation and condensation, meteorologists hope eventually to be able to use computing machines to make numerical weather forecasts for 5 to 30 days, or perhaps even further into the future. Such long-range predictions, however, are not expected very soon.

Experts in numerical forecasting believe this system has two advantages over present methods:

1. The computer can use and store in its "memory" many hundred times as much information as a human forecaster could possibly keep in his head.

2. A human forecaster cannot use a precise, step-by-step, hour-by-hour method and stay ahead of the weather. He has to jump directly to the desired future time by subjective methods. Step-like predictions are more accurate than such relatively long-time jumps.

Scientists in the News

Paul R. Burkholder, Professor of Botany and Chairman of the Department of Plant Science at Yale University, has resigned to accept appointment as Chairman of the Department of Microbiology at the University of Georgia. He is succeeded, for the year 1953–54, by **Paul B. Sears,** who will continue with his previous duties as Chairman of the Yale Conservation Program.

Paul Gyorgy, Chief of Service, Department of Pediatrics, Hospital of the University of Pennsylvania, delivered the 37th Mellon Lecture before the Society for Biological Research of the School of Medicine, University of Pittsburgh, on Nov. 20. Subject: Some Aspects of Protein Nutrition.

Five scientists and two organizations distinguished for medical research and public health achievement have been named as the 1953 winners of the annual **Albert Lasker Awards** of the American Public Health Association. The awards, considered among the nation's highest medical honors, were presented formally at the Association's 81st annual meeting on Nov. 12. The individual winners received cash prizes of $1000, hand-illuminated and leather-bound citations, and gold statuettes of the Winged Victory of Samothrace. The group winners received silver statuettes, statuettes that are symbolic of victory over death and disease. A list of the winners follows:

Hans A. Krebs, 54, Professor of Biochemistry at the University of Sheffield, England, who recently was named to share the 1953 Nobel Prize for Medicine and Physiology. Dr. Krebs was cited as the "discoverer of the urea and citric acid cycles which are basic to our understanding of how the body converts food into energy."

Felix J. Underwood, 71, of Jackson, Miss., state health officer for 30 years, "for demonstrating how a long-sustained, sound, and expanding pattern of public health services benefits a people."

Michael Heidelberger, 65, Professor of Immunochemistry at Columbia University's College of Physicians and Surgeons, "for decisive contributions to mankind in developing a new subscience, the precise measuring tool of immuno-chemistry."

George Wald, 47, Professor of Biology at Harvard University, "in recognition of his outstanding achievements in explaining the chemistry of vision in man."

The late **Prof. Earle B. Phelps,** research engineer at the University of Florida, "in recognition of a lifetime of pioneering and leadership in public health and sanitary science." Prof. Phelps died at 76 last June shortly after notice of his selection for the award. A son, Winston Phelps, received the award for the family.

The Division of Research Grants of the National Institutes of Health, Bethesda, Md., "for outstanding administration of a research grants program enabling thousands of capable scientists in hundreds of institutions to contribute knowledge substantially advancing the nation's health." **Ernest Allen,** director, received the award on behalf of the division.

The University Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University, "for basic protein studies leading to fundamental achievements in the field of blood separation, and more particularly, in gamma globulin preparation." Douglas M. Surgenor, executive officer of the laboratory, received the award which was to have been presented to **Edwin J. Cohn,** director of the laboratory until his death Oct. 1.

At the 4th annual convention of the United Cerebral Palsy Association on Nov. 14, **Horace W. Magoun,** neuroanatomist at the School of Medicine, University of California at Los Angeles, was awarded the $1000 Max Weinstein Prize. Dr. Magoun was honored for his study of the cerebral cortex and basal ganglia in relation to cerebral palsy. He has also investigated factors promoting regeneration of nerve fibers in the central nervous system.

J. Kenneth Salisbury, formerly engineer in charge

of thermal power system development for the General Electric Company, is now professor of mechanical engineering at Stanford University.

Heyworth N. Sanford, who has served as acting head of the Department of Pediatrics at the University of Illinois College of Medicine since September, 1952, has been appointed head of the department.

Charles T. West has been appointed Acting Chairman of the Department of Mechanics in the College of Engineering at Ohio State University.

Harold O. Wyckoff, who joined the National Bureau of Standards in 1941, has been appointed Chief of the Radiation Physics Laboratory.

Education

The first graduate school in France devoted to advanced training of engineers in work with reinforced concrete has been opened. It is called **L'Institut Superieur du Beton Arme** and it is located at 110 Boulevard de la Liberation, Marseille.

A **matching plan** designed to eliminate some of the problems of selecting candidates for admission to medical schools has been proposed by John A. D. Cooper and Harold A. Davenport in an article published in the October issue of *The Journal of Medical Education*. The matching plan is designed to enable the student applicant and the medical school to form a mutually satisfactory association without the anxieties and pressures that now occur. Some of the current problems stem from the fact that approximately three times as many students apply to medical schools as can be admitted. The projected system is modeled after the highly successful intern-hospital matching plan which has operated for the past three years.

Under the plan, students would remain free to apply for admission to the school or schools of their choice, and the medical schools would be allowed free indication of preference. All choices, to be filed at the central office of the Association of American Medical Colleges, would be confidential. A deadline for applications to the medical schools would be set, possibly for March 1. Sometime within the succeeding two months each medical school would mail to the Association's central office a list of applicants arranged in order of preference, rejecting any not qualified for admission by their own standards. Simultaneously, students would send in a list, also arranged in order of preference, of the medical schools to which they had applied. A card for each applicant would be made by the central office; then the matching would be accomplished with complete objectivity, governed entirely by the information recorded on IBM punch cards.

The plan helps the applicant to gain admission to the school of his first choice, and at the same time allows each school to secure the highest ranking students available to it. The authors point out that the system offers numerous advantages, not the least being the uniform deadline dates for applications. At the present time, each school sets its own dates. This creates much uncertainty, sometimes resulting in a student accepting a place in a school with an early deadline, only to withdraw when later a preferred school selects him as a candidate.

The 1953–54 list of lecturers available through the **Oak Ridge Traveling Lecture Program** has been prepared. The list includes 68 lecturers in the physical sciences and 22 in the biological sciences. Practically all of the lecturers are members of the staff of Oak Ridge National Laboratory.

As its name implies, the Traveling Lecture Program was established to provide speakers from Oak Ridge for college and university functions such as graduate seminars, symposia, colloquia, and departmental meetings. This was early recognized as one of the means through which the Oak Ridge scientific staff could add its weight to efforts to strengthen education in this region. Conversely, the stimulation of the campus and the opportunity of meeting new people is felt to be of value to the Oak Ridge scientists. The Traveling Lecture Program is a joint activity of the Oak Ridge Institute of Nuclear Studies and ORNL. Copies of the new schedule of lectures may be obtained from the University Relations Division of the Institute.

Grants, Fellowships, and Awards

The Alfred P. Sloan Foundation has announced a second series of 25 scholarships to be awarded on the basis of a national competition during 1954. The scholarships, known as the **Alfred P. Sloan National Scholarships,** and financed by the Foundation, will be awarded and administered by four of the nation's leading technological institutions: California Institute of Technology, Carnegie Institute of Technology, Cornell University College of Engineering, and the Massachusetts Institute of Technology. Recipients will be selected on a national basis from applicants received by all four of these schools.

Any male student resident in the continental United States, who meets the formal entrance requirements of the cooperating institutions, is eligible to apply for these scholarships. Applications may be made to one or more of the four institutions; in case of a duplicate award, the recipient will be free to accept the award at the school of his choice. The scholarships will apply to all courses of study at CalTech; only to courses of study in the College of Engineering and Science at the Carnegie Institute; only to courses of study in the College of Engineering at Cornell; and to all courses of study except Architecture and City Planning at MIT. The scholarships carry a maximum annual stipend of $2000. They may be renewed after the first year.

At the 10th Annual Meeting of the **American Medical Writers' Association** new regulations were adopted for the Association's Journalism Awards. These awards are given annually to U.S. and Canadian

medical periodicals and are made possible by a gift from Harold Swanberg, Secretary of the Association. The new regulations divide medical periodicals into six classifications with an award for each, i.e., the general medical periodicals, specialty journals, city or county medical society bulletins, and the free journals of pharmaceutical, publishing, and related companies. The awards are akin to the Pulitzer Prizes given to newspapers, and nominations are conducted in a similar manner.

The same Review Committee which served last year will again function in 1954. It consists of Morris Fishbein, chairman, F. Smiley of Chicago, and Richard M. Hewitt of Rochester, Minn. *Nominations for the 1954 awards must be received by Feb. 1, 1954.* Regulations and nominating forms may be obtained from Harold Swanberg, M.D., W.C.U. Bldg., Quincy, Ill.

Eight **fellowships in industrial medicine** will be offered by the U.S. Atomic Energy Commission for the 1954–1955 academic year. The fellowship program, begun by the AEC four years ago, is designed to provide advanced training and on-the-job experience for men and women physicians in the field of industrial medicine, particularly in relation to the atomic energy industry.

The fellowships are open to United States citizens who hold M.D. degrees from approved medical schools, and who have had at least one year of internship. In exceptional cases, equivalent experience may be accepted in lieu of the internship requirement. Successful candidates must be investigated by the FBI and approved by the AEC before receiving fellowships.

Awards are for one year's academic training at institutions which offer approved graduate courses in industrial medicine and which can provide special training facilities in the health problems associated with the atomic energy program. Normally, fellows will be eligible for a second, or in-plant, training year upon successful completion of the academic year. In-plant training will be given in medical departments of major AEC plants and laboratories.

There is a critical need for qualified industrial physicians in atomic energy installations, and at the end of the two-year training period fellows may find employment in the program. However, there will be no commitment on the part of the AEC to continue the applicant's training beyond the first year or to provide employment for him upon the completion of training. Fellows will not be obligated to take the second year of training or to seek employment with the AEC or its contractors.

The stipend during the first year is $3600, with $350 additional for a wife and for each dependent child. Tuition and laboratory fees will be paid. The stipend for the second year is $6000, with no additional amounts for a wife or children. The program is administered for the AEC by the Atomic Energy Project of the School of Medicine and Dentistry, University of Rochester, Rochester, New York. Fellows are selected by a committee headed by Robert A. Kehoe, Director, Institute of Industrial Health, University of Cincinnati, and Medical Director, Ethyl Corporation. *Applications for 1954–55 fellowships should be submitted by Jan. 1, 1954 to*: AEC Fellowships in Industrial Medicine, Atomic Energy Project, University of Rochester, School of Medicine and Dentistry, Rochester, N.Y. Attention: Dr. Henry A. Blair.

For the third successive year the **Ford Foundation** is offering a number of foreign study and research grants in keeping with its policy of supporting selected activities which may contribute to international understanding. These fellowship awards will be given to younger American men and women of ability who wish either to begin or continue study or research concerning Asia, the Near and Middle East.

Students who will graduate from college next year are invited to apply, as well as persons who have completed their formal educational training and have already initiated their careers. While the Board cannot undertake to obtain leaves of absence for successful applicants, it will encourage employers to permit acceptance of these grants without termination of employment. Application forms may be obtained from the Ford Foundation Board on Overseas Training and Research, 575 Madison Avenue, N.Y. 22, N.Y. *Applications must be completed and returned on or before Jan. 8, 1954.* The awards will be announced on or about April 15, 1954.

In the Laboratories

The **American Cyanamid Company** plans to build a new plant for the manufacture of titanium dioxide pigments at Savannah, Ga. The plant will be operated by the Calco Chemical Division, a major producer of titanium dioxide white pigments for manufacturing industries such as paint, paper, hard floor covering, ceramic, rubber, and plastic.

The **Borden Company's Chemical Division** has concentrated its general research facilities in a new laboratory in Philadelphia, a laboratory which will augment the Division's present Development and Applications Laboratories on the East and West coasts. Research in a wide range of basic problems in materials evaluation, production processes, and applications for new and improved products of the Chemical Division's line of chemicals, resins, and adhesives.

The **Engineering Research Institute of the University of Michigan** is undertaking research on the atmospheric diffusion and penetration into buildings of allergenic pollens and industrial contaminants, under the sponsorship of the Geophysics Research Directorate of the Air Force Cambridge Research Center. The Department of Civil Engineering and School of Public Health are associated with the Institute in the research program. The principal investigator is E. Wendell Hewson, with Earnest Boyce and Clarence J. Velz acting in an advisory capacity.

Meetings and Elections

The Winter General Meeting of the **American Institute of Electrical Engineers** will be held in New York City, Jan. 18–22, 1954. The Institute, which was organized in 1884, has a world-wide membership of more than 46,000 and is the largest technical society of its kind.

The **American Society for the Study of Arteriosclerosis** has elected the following officers for 1953–54: pres., Russell L. Holman; v. pres., Louis N. Katz; sec.-treas., O. J. Pollak.

Physicians and scientists are invited to present papers at the **VIth International Cancer Congress** to be held in São Paulo, Brazil, July 23–29, 1954, under the sponsorship of the International Union Against Cancer. The program will include sections on fundamental cancer research, on clinical studies on cancer, and on cancer control. Registration blanks are available from the Chairman, National Committee on the International Union Against Cancer, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C.

It is expected that round trip transportation by air from Miami to São Paulo will be available for about $480. Detailed information regarding travel arrangements and hotel reservations may be obtained from Dr. Brewster S. Miller, American Cancer Society, Inc., 47 Beaver Street, New York 4, New York.

In accordance with similar arrangements being made in other countries to coordinate participation in the Congress, residents of the United States who desire to present papers must send *five* copies of an abstract of each paper proposed for presentation to the Chairman, National Committee on the International Union Against Cancer, at the above address *by January 15, 1954*. Abstracts are not to exceed 250 words and must be accompanied by a title and the name, address, academic or professional title, and institutional affiliation of the investigator or physician. These requirements do not apply to people who have been invited to participate by the President of the Congress, unless application is made for travel allotments as described below.

Travel allotments of approximately $600 each will be available to a limited number of individuals requiring such assistance. Applications for travel allotments must be submitted in quintuplet to the Chairman, National Committee on the International Union Against Cancer, at the above address *by January 15, 1954*. They should be in letter form giving information concerning age, training, publications in cancer or related fields, and academic or professional status. Applicants not planning to present papers should include five copies of abstracts, as described above, of major current investigative work. A letter from the laboratory director, or appropriate administrative officer, approving the application is also necessary.

J. R. Porter, Chairman of the Department of Bacteriology, School of Medicine, University of Iowa, has been appointed Chairman of the **Office of Naval Research Advisory Panel for Microbiology.** Other members of the panel are as follows: W. J. Cromartie, University of North Carolina; N. F. Conant, Duke University; Emil Mrak, University of California; H. R. Morgan, University of Rochester; W. D. McElroy, The Johns Hopkins University; and H. P. Treffers, Yale University. The fall meeting of the Panel will be held in Washington, D.C., Dec. 7–8. Applications for the support of research in the field of microbiology will be reviewed at this time.

The program of the Microbiology Branch of ONR includes projects in bacteriology, virology, parasitology, mycology, and immunology. At present this branch has under supervision nearly 90 contracts with 52 universities in 29 states.

The **New Orleans Academy of Sciences** has elected the following officers for 1953–54: pres., Karlem Riess, Tulane University; v. pres., Joseph A. Ewan, Tulane University; sec., John H. Mullahy, Loyola University; treas., Philip C. Wakeley, U.S. Forest Service; curator, Garland Taylor, Tulane University.

A **Scintillation Counter Symposium,** which will present recent advances in this branch of technology, will be held in Washington, D.C., Jan. 26–27, it has been announced by the American Institute of Electrical Engineers, one of the four sponsors. The other sponsors are the Institute of Radio Engineers, the Atomic Energy Commission, and the National Bureau of Standards.

The meeting will consist of four sessions on energy spectrometry, cosmic ray and high energy particle measurements, scintillation counter applications, and phosphors and photomultipliers. The design and performance of instruments and the components of scintillating counter instruments, and the application of such counters to the solution of both industrial and purely scientific problems, also will be discussed.

G. A. Morton, R. C. A. Laboratories, Princeton, N.J., is chairman of the symposium committee and H. O. Wyckoff of the National Bureau of Standards is chairman of the attendance committee.

Since 1953 marks the 200th anniversary of the publication of one of Linnaeus' most important works, *Species Plantarum,* the Hawaiian Botanical Society considered it appropriate to sponsor a **symposium on the life and work of Linnaeus.** Speakers who participated in the bicentenary program were Constance Hartt, the life of Linnaeus; J. Lloyd Collins, Linnaeus and the early stages of geneties; F. G. Krauss, Linnaeus' botanical garden and the place of botanical gardens in science; Harold St. John, Linnaeus as a physician and the place of early naturalists in the medical profession; and Maxwell S. Doty, the *Species Plantarum* of Linnaeus and its importance in botany.

It is suggested by the Society that other organizations would do well to make similar observance of the bicentennial of the publication of this classical work.

Miscellaneous

Assumption College, Worcester, Mass., which was partially destroyed in the tornado of June 9, 1953, is in dire need of collateral reading matter in the field of science. Any reasonably recent book that could become part of a reading list in chemistry, biology, or allied sciences would be most welcome.

The **Medical Indexing Research Project,** carried out at the Welch Medical Library of The Johns Hopkins University under the direction of Sanford W. Larkey, and sponsored and underwritten by the Armed Forces Medical Library, has now come to a close. Under the contract, work began on Nov. 5, 1948, and came to an end Sept. 30, 1953, fulfilling the original prediction that 4 or 5 years would be required for this effort. The cost of the project averaged approximately $2170 per month over the entire period, including salaries, machine rentals, supplies, equipment and maintenance, and overhead charges. For most of the period 5 persons were employed on the investigative and clerical staff. A final report of the work is expected by the end of the year.

A group of educators, headed by John D. Rockefeller III, has formed a non-profit corporation, to be known as **The Population Council, Inc.,** to encourage research and education concerning the relationship of the world's population to its material and cultural resources. The new organization has opened offices at 230 Park Ave., New York City. Frederick H. Osborn, a writer on population factors, will serve as executive vice president with responsibility for directing the work of the Council during its formative period. Mr. Osborn is a director and past president of the Population Association of America and secretary of the American Eugenics Society. He is also a trustee of the Council, as are Frank G. Boudreau, Detlev W. Bronk, Karl T. Compton, Frank W. Notestein, Thomas Parren, John D. Rockefeller III, and Lewis L. Strauss.

The basic purposes of the Council are as follows: to study the problems presented by the increasing population of the world; to encourage and support research and the advancement and diffusion of knowledge resulting from such research; to serve generally as a center for the collection and exchange of information on ideas and developments relating to population questions; to cooperate with individuals and institutions having similar interests; and to take the initiative in the broad fields that constitute the population problem.

Recent Deaths

Francis H. Allen (87), ornithologist and editor, Cambridge, Mass., Oct. 24; **Frank K. Boland** (78), surgeon and former vice chairman of the American Medical Association, Atlanta, Ga., Nov. 11; **Ned J. Burns** (53), head of the museums of the National Park Service, Washington, D.C., Oct. 12; **Max Danzis** (79), surgeon and cofounder of Beth Israel Hospital, Newark, N.J., Oct. 20; **William H. Donner** (89), philanthropist and president of the International Cancer Research Foundation, Philadelphia, Pa., Nov. 3; **Gaston F. DuBois** (73), consulting chemical engineer and former president of Monsanto Chemical Co., St. Louis, Mo., Nov. 1; **Alice Eastwood** (94), former curator of botany at the California Academy of Sciences, San Francisco, Calif., Oct. 30; **Martin F. Engman** (84), founder of the National Leper Home at Carville, La., and former clinical professor of dermatology at Washington University, St. Louis, Mo., Oct. 12; **William L. J. Griffin** (75), former lecturer on the history of dentistry at the University of Pennsylvania, Philadelphia, Pa., Oct. 23; **George A. Grubb** (73), dean emeritus of the University of Nebraska College of Dentistry, Lincoln, Neb., Nov. 1; **Percival Hall** (81), president emeritus of Gallaudet College, Washington, D.C., Nov. 7; **Harry P. Hammond** (68), dean emeritus of the School of Engineering at the Pennsylvania State College, State College, Pa., Oct. 21; **James B. Hays** (64), designing engineer, Summit, N.J., Oct. 24; **Edwin E. Jacobs** (76), science writer and president emeritus of Ashland College, Ashland, Ohio, Oct 31; **Carl Kelsey** (83), author and emeritus professor of sociology at the University of Pennsylvania, Philadelphia, Pa., Oct. 15; **Albert M. Kessel** (44), chief of the pathological technology unit of the National Cancer Institute, Bethesda, Md., Oct. 14; **Charles L. Kinsloe** (71), former professor and head of the Department of Electrical Engineering at the Pennsylvania State College, State College, Pa., Oct. 14.

Maxime Laignel-Lavastine (78), psychiatrist and medical historian, Paris, France, Sept. 5; **Maurice Lugeon** (83), geologist, Lausanne, Switzerland, Oct. 23; **Ewen Maclean** (88), surgeon, obstetrician, gynecologist, and former president of the British Medical Association, Cardiff, Wales. Oct. 13; **Harry A. Marmer** (68), former assistant chief of the Div. of Tides and Currents of the Coast and Geodetic Survey, Washington, D.C., Nov. 5; **George E. Marsh** (76), former professor and retired electrical engineer for the Veterans Administration, Washington, D.C., Oct. 16; **Charles F. Martin** (85), prominent physician and former dean of the Faculty of Medicine at McGill University, Montreal, Canada, Oct. 28; **Frank Mossberg** (94), mechanical engineer, inventor, and president of the Mossberg Engineering Co., Attleboro, Mass., Oct. 15; **Ernest Myller** (60), gynecologist and obstetrician, New York City, Oct. 23; **James E. Rice** (88), former professor of poultry husbandry at Cornell University, Ithaca, N.Y., Oct. 25; **Albert Strickler** (68), former professor of skin diseases at Temple University and founder of the Skin and Cancer Hospital, Philadelphia, Pa., Nov. 8; **Sterling P. Taylor, Jr.** (30), researcher and instructor in biochemistry at Cornell University Medical College, New York City, Oct. 9; **Robert J. Trinkle** (61), professor and head of the Department of Mechanical Engineering at Virginia Military Institute, Lexington, Va., Oct. 18; **Jacques S. Uhr** (61), pediatrician and researcher in allergy treatment, New Brunswick, N.J., Oct. 9.

Technical Papers

The Relationship Between *Trichobilharzia oregonensis* and *T. elvae*, Etiological Agents of Schistosome Dermatitis in the Pacific Northwest[1]

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Considerable confusion exists as to the status of various European and American species of schistosomes which cause dermatitis in man. Technical difficulties involved in experimental work, especially the recovery of intact adult worms, are largely responsible for this state of affairs. Recently we have been able to clarify the relationship between two species found in the Pacific Northwest.

In 1946, *Cercaria oregonensis* was described as a new species of schistosome found at Portland, Oregon, capable of producing dermatitis in man (*1*). Although this cercaria is similar to that of *Trichobilharzia elvae* Miller, there are certain minor differences in measurements and behavior, and the snail host is *Physa ampullaria* instead of *Lymnaea stagnalis* and *Stagnicola palustris elodes* which are hosts of the former species. If *T. elvae* is synonymous with *T. ocellata*, as believed by McMullen and Beaver (*2*), then this species is found in Europe, in addition to a wide North American geographical range.

Snails infected with *Trichobilharzia elvae* were transported more than 300 miles from Cascade Lake on Orcas Island, Puget Sound, Washington, where one of us (R. W. M.) has studied the biology of the species (*3*). A series of Pekin ducklings was infected with cercariae of *T. elvae* from *Lymnaea stagnalis* and a second group of these birds was given cercariae of *T. oregonensis* from naturally infected *Physa* snails collected at Portland, Oregon. Representative cercariae from each snail were measured in order to exclude the possibility of mixed infections, especially with *T. physellae* which sometimes occurs in *Physa* in the vicinity of Portland.

As indicated by the use of McMullen-Beaver flasks (*2*), about two weeks were required for the maturation of both species of worms. Eggs of *T. elvae* imbedded in the intestinal wall of the ducks showed the typical curved axis, producing a moon shape, whereas those of *T. oregonensis* were found to be more nearly straight and closely resembled those of *T. physellae*. However both the adults and cercariae are strikingly different from those of the latter species. The small cercaria of *T. physellae*, which we have studied here, has fewer flame cells than those of either *T. elvae* or *T. oregonensis* and closely fits the description given by Talbot (*4*) for *T. elvae*.

Adults of *Trichobilharzia oregonensis*, some of them undamaged, were laboriously recovered in small numbers from the venules of the intestinal wall of the ducklings and were found to differ markedly from those of *T. elvae* as described by McMullen and Beaver. Although the average body length is only a little larger than that of *T. elvae*, the acetabulum of *T. oregonensis* averages 0.046 mm in diameter, approximately the same as the oral sucker, and is about three to four times the diameter of the acetabulum of the former species. Further, the seminal vesicle of the male is followed by a still longer, similar structure, bordered on the posterior end by a prostate mass, and probably therefore is a very elongate cirrus sac. These relationships were constant in six males examined.

Our work clearly demonstrates that at least three distinct species of *Trichobilharzia* occur in the Pacific Northwest. Further details will be published elsewhere.

[1] This work was supported by contract Nonr-153 (00), NR 132-992, between the Office of Naval Research, Department of the Navy, and Reed College.

References

1. MacFarlane, D. G., and Macy, R. W. *J. Parasitol.*, **32**, 281 (1946).
2. McMullen, D. B., and Beaver, P. C. *Am. J. Hyg.*, **42**, 128 (1945).
3. Macy, R. W. *Northwest Med.*, **51**, 947 (1952).
4. Talbot, S. B. *Am. J. Hyg.*, **23**, 372 (1936).

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Estrogenic Activity in a Commercial Animal Ration

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In the course of some experimental work involving castrated mice during the past year, it became apparent that the animals were showing the presence of an appreciable amount of estrogen. Observations revealed that the vaginal smears of these mice contained many cornified cells. Examination of the uteri of representative mice taken from a group of 100 castrated animals revealed uterine weights of more than 40 mg. Since it had been previously demonstrated in our colony that the uteri of mice castrated for about 2 wk weighed approximately 12 mg, it was apparent that the animals were being exposed to an estrogen.

These observations led us to suspect the presence of an estrogen in the food and as a result the mice were placed on a new commercial ration (A). Following this change in diet the vaginal smear became negative and contained only leucocytes and an occasional epithelial cell. In order to prove the source of the estrogen, 1 kg of the suspected diet (B) was extracted with petroleum ether and taken up in 30 ml of oil. The material was then tested for estrogenic activity by the uterine weight method, using castrated mice.

TABLE 1

ESTROGENIC ACTIVITY IN AN EXTRACT OF A COMMERCIAL FOOD RATION (B) FOR LABORATORY ANIMALS

No. of mice	Av. body wt., g	Treatment	Mean uterine wt., mg
8	28.6	16 days castrated	11.2 ± 1.4
8	31.2	23 days castrated	13.3 ± 1.3
10	30.5	Estradiol, 0.002 μg/day	23.1 ± 2.7
10	29.2	Estradiol, 0.005 μg/day	24.2 ± 1.9
10	31.5	Estradiol, 0.01 μg/day	40.0 ± 1.4
10	29.2	Estradiol, 0.1 μg/day	97.3 ± 8.7
10	29.1	Food extract, 0.05 ml/day	24.6 ± 2.1
9	28.7	Food extract, 0.1 ml/day	53.6 ± 2.0

The animals were rested for 15 days posteastration and then injected daily for 7 days. The mice were killed 24 hr after the last injection, the uteri dissected out, split longitudinally to remove luminal water, and weighed immediately on a torsion balance.

It may be seen from the data in Table 1 that castration atrophy was complete by the 16th day. The mean uterine weight of mice castrated for 16 days was found to be 11.2 mg and that from mice castrated for 23 days was 13.3 mg. Since the body weights averaged approximately the same for each group of mice, it was not deemed necessary to convert the uterine weights to a per cent body weight figure. A standard dose-response curve was established with estradiol over a dosage range of 0.002 μg to 0.1 μg/day; these concentrations gave an adequate curve for assay purposes. The extract was injected at two dose levels, and in all instances a constant volume of 0.1 ml was injected. The equivalent of 0.05 ml of the extract increased the mean uterine weight to 24.6 mg, whereas 0.1 ml resulted in a mean uterine weight of 53.6 mg. Analysis of the data revealed that 1 kg of food contained an estrogenic potency equivalent to 3.75 μg of estradiol.

Although no direct evidence is available for the nature of the estrogen, it would not appear to be estradiol since the substance showed high oral activity. If one speculates on the source of the estrogen as due to implanted pellets used in the poultry industry (*1*, *2*) and as having gotten into the food as waste scraps of meat, then one could conclude that the substance is a synthetic estrogen since these are the substances used by poultry breeders. It is of interest to note that several years ago the feeding of neck scraps from implanted birds caused sterility in mink (*3*).

There is also a possibility that the estrogen came from a plant source. Investigators have shown the presence of estrogenic activity in glycyrrhiza (*4*), willow (*5*), wheat germ oil (*6*), date palm tree (*7*), clover (*8*, *9*), and alfalfa (*9*). Recently an isoflavone derivative has been isolated from soybean oil meal with estrogenic activity (*10*). Thus it is highly possible that the source of the hormone could have been from added plant material.

Regardless of the source of the estrogen, an appreciable amount of the hormone was found in a commercial food ration. The concentration was sufficiently high to prevent castration atrophy as noted by changes in the uterus and the vagina. This could easily invalidate many experiments and would definitely interfere with any assay for estrogen or with the Hooker-Forbes test for progesterone (*11*, *12*). It would thus appear essential that proper controls be maintained at all times for possible food contamination with an estrogen.

References

1. LORENZ, F. W. *Poultry Sci.*, **22**, 190 (1943).
2. ———. *Ibid.*, **24**, 128 (1945).
3. Hearings before Subcommittee No. 2 of the Committee on the Judiciary, House of Representatives, Eighty-second Congress. First session on H. R. 846, H. R. 1568, H. R. 2591, H. R. 2592, H. R. 2776, and H. R. 2777 for the relief of various mink ranchers, March, 1951. Serial No. 2, U. S. Govt. Printing Office, Washington.
4. COSTELLO, C. H., and LYNN, E. V. *J. Am. Pharm. Assoc.*, **39**, 177 (1950).
5. SKARZYNSKI, B. *Nature*, **131**, 766 (1933).
6. LEVIN, E., BURNS, J. F., and COLLINS, V. K. *Endocrinology*, **49**, 289 (1951).
7. HASSAN, A., and WAFA, M. H. *Nature*, **159**, 409 (1947).
8. CURNOW, D. H., ROBINSON, T. J., and UNDERWOOD, E. J. *Australian J. Exptl. Biol. Med. Sci.*, **26**, 171 (1948).
9. CHENG, E. W., *et al. J. Animal Sci.*, **11**, 758 (1952).
10. CHENG, E., *et al. Science*, **118**, 164 (1953).
11. OLSEN, A. G., SALHANICK, H. A., and HISAW, F. L. *Endocrinology*, **51**, 519 (1952).
12. ZARROW, M. X., and NEHER, G. M. *J. Clin. Endocrinol. and Metabolism*, **13**, 203 (1953).

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Comparative Studies in the Uptake of Phosphorus by Tissues under Different Doses of Injected Radioactive Phosphorus P^{32} [1]

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Radioactive phosphorus (P^{32}) is one of the few radioisotopes that have been used in therapy (*1*, *2*). When a radioisotope in soluble form is injected or administered by mouth, it is deposited with greater or less selectivity in different organs. A knowledge of this differential uptake is essential for a correct estimate of the radiation dosage and for successful radioisotope therapy (*3*). The results of early investigations on the relative concentration of P^{32} in different organs of experimental animals and of the time variation of the concentration have been summarized by Hevesy (*4*) and Chaikoff and Zilversmit (*5*).

In this work we have attempted to find out how the relative concentration of phosphorus by tissues is affected by different doses of the injected radioisotope. This seems to be of fundamental importance, not only for the correct estimation of the therapeutic dose of radioactive material, but also for showing the disturbances in metabolism produced by different doses of beta irradiation from P^{32}.

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[2] Indebtedness to Atomic Energy Commission for the award of Research Fellowship is gratefully acknowledged.

TABLE 1

PERCENTAGE OF ADMINISTERED P^{32} RECOVERED 72 HR AFTER INJECTION

Organ	Dose, 0.3 μc/g		Dose, 0.5 μc/g		Dose, 1 μc/g		Dose, 4.5 μc/g	
	1 g tissue	Whole organ	1 g tissue	Whole organ	1 g tissue	Whole organ	1 g tissue	Whole organ
Bone	2.08	18.6	2.24	20.0	2.28	20.4	1.8	16.0
Liver	1.26	8.9	1.16	8.2	1.37	9.6	1.47	10.3
Spleen	.92	.32	.95	.33	1.1	.38	1.1	.38
Small intestine	.74	1.9	.78	2.0	1.1	2.9	.9	2.3
Stomach	.66	.59	.79	.70	.7	.62	.87	.77
Kidney	.69	.86	.47	.58	.57	.71	1.0	1.2
Muscle	.6	30.0	.53	27.0	.57	29.0	.6	30.0
Lung	.49	.41	.49	.41	.56	.46	.63	.53
Heart	.44	.25	.32	.19	.47	.27	.63	.36
Skin and hair	.35	6.3	.36	6.5	.27	4.9	.35	6.3
Brain	.14	.24	.14	.24	.21	.37	.23	.41
Blood	.13	1.10	.13	1.10	.16	1.32	.15	1.23
Total		69.47		67.25		70.93		69.78

P^{32} was injected into rats in amounts of 0.3, 0.5, 1.0, and 4.5 μc/g of body weight. The maximum dose of 4.5 μc/g of body weight was lethal (*6, 7*). All rats receiving that dose of radioisotope died within 12 days after the injection.

In all, 48 albino rats divided into 4 groups were used. Each animal was injected intraperitoneally with a single dose of carrier-free radioactive phosphorus in the form of isotonic Na_2HPO_4.[3] At the end of 72 hr the animals were anesthetized and tissues and blood samples obtained. The tissues were weighed wet and a portion thereof hydrolyzed or fused and assayed for radioactivity.

All uptake measurements were carried out with a hundred scaler circuit, shielded manual sample changer, and end-window type of Geiger-Müller counters with a window thickness of about 4 mg/cm². In order to allow for decay, during the period between the measurement of uptake and the injection of radiophosphorus, the beta activity in the tissue sample was always compared with that of a standard aliquot of the administered dose measured under identical conditions. The activity in the total organ was obtained by multiplying the mean concentration per gram of tissue by the average weight of the whole organ.

Table 1 indicates the activity in different tissues, both per gram of fresh tissue and in the whole organ, 72 hr after injection of P^{32}, expressed as percentage of the administered dose.

For the 4 doses of P^{32} used in these experiments, the average of the total activity recovered from all organs listed was about 69%. The activity in the excreta measured during the same period accounted for 21% and the remaining 10% of the activity was concentrated in organs not listed in the table.

For each dose, bone had the highest concentration of P^{32}/g of tissue; next in order of concentration were liver and spleen. Among the other organs, the activity per gram of tissue decreased in the order in which they are listed. Although the dose of radioisotope varied from 0.3 μc/g to 4.5 μc/g of body weight, the percentage of uptake was found to be practically independent of the dose. The slight differences noted in the table are not statistically significant, even for the lethal dose of 4.5 μc/g of P^{32}. Assuming homogeneous distribution of P^{32} throughout the tissues, with the doses of 0.3, 0.5, 1.0, and 4.5 μc/g of body weight, the animals were subjected to cumulative whole body beta irradiation throughout the first 3 days at the average rates of 10, 17, 34, and 153 r/day (*6*). Although the calculated doses are approximate, the present experiment shows that with these rates of beta irradiation, no appreciable difference is noticeable in phosphorus metabolism within the first 3 days.

If the relative concentration of P^{32} in different tissues reaches approximate equilibrium within the first 3 days of its administration (*7, 8*), and thereafter it is eliminated with an effective half-life dependent only on physical decay and excretion, then the dose of beta irradiation delivered to different organs is roughly proportional to the concentration of P^{32}/g of fresh tissue. A comparison of the measured uptakes (Table 1) shows that with this method of administration, the bones receive 3–4 times as much radiation as the muscles, which again receive about 4 times as much radiation as blood.

[3] Obtained from A.E.R.E., Harwell.

References

1. LOW-BEER, B. V. A. In: *Medical Physics, Vol. II*, O. Glasser, Ed. Chicago: Year Book Publ. 1950, p. 456.
2. LAWRENCE, J. H., *et al. J. Am. Med. Assoc.*, **136**, 672 (1948).
3. MARINELLI, L. D., QUIMBY, E. H., and HINE, G. J. *Am. J. Roentgenol. Radium Therap. Nuclear Med.*, **59**, 260 (1948).
4. HEVESY, G. *Radioactive Indicators*. New York: Interscience, 1948.
5. CHAIKOFF, I. L., and ZILVERSMIT, D. B. In: *Advances in Biological and Medical Physics, Vol. I*. J. H. Lawrence and J. G. Hamilton, Eds. New York: Academic Press, 1948, p. 321.
6. MITRA, S., *et al. Acta Radiol.* In press.
7. KOLETSKY, S., and CHRISTIE, J. H. *Am. J. Pathol.*, **27**, 175 (1950).
8. COHN, W. E., and GREENBERG, D. M. *J. Biol. Chem.*, **123**, 185 (1938).

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Effects of Intravenous Heparin on the Plasma Lipoproteins in Primary Hypercholesteremic Xanthomatosis and Idiopathic Hyperlipemia[1]

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The action of heparin on the plasma has been studied in 7 normal subjects, 8 patients with primary hypercholesteremic xanthomatosis and 7 patients with idiopathic hyperlipemia. Electrophoretic analyses in a Tiselius apparatus as well as determinations of the lipids and of the turbidity of the plasma were carried out before and 15 minutes after the intravenous injection of 50 mg of heparin. The results are briefly outlined here; they will be reported in detail elsewhere (*1*).

In 5 of the 7 normal subjects the electrophoretic pattern revealed no changes after the injection of heparin, while in 2 the size of the β-1 peak decreased to less than half of its normal size. Compensating for this decrease there was in one person an increase in both the α-1 and albumin peaks, and in the other an increase in the α-2 peak. No significant changes occurred in the values for cholesterol, phospholipids, or neutral fat following the injection of heparin.

In primary hypercholesteremic xanthomatosis, in which the values for cholesterol and phospholipids are elevated and the plasma is clear, the fasting electrophoretic pattern showed an abnormally high β-1 peak in all 8 patients. Following the injection of heparin no changes occurred in 2 patients, while in 6 patients the β-1 peak decreased considerably, from an average of 16.8% to 7% of the total protein, a value far below the normal average value of 13% (Fig. 1). Compensating for the decrease in the size of the β-1 peak there was an increase in the size of the α-2 peak in 3 patients; of the albumin peak in 1 patient; and of both the α-2 and albumin peaks in 2 patients. No changes occurred in the amounts of neutral fat or phospholipids; but the elevated cholesterol values decreased slightly in all 8 patients, from an average of 444 mg/100 ml of plasma to 417 mg.

In idiopathic hyperlipemia, in which not only the values for cholesterol and phospholipids but also for neutral fat are elevated and the plasma is creamy, the fasting electrophoretic pattern showed an abnormal elevation of the α-2 peak in 3 patients, and of both the α-2 and β-1 peaks in 3 patients. In the seventh patient the pattern was obscured by the very great turbidity of the plasma. After the injection of heparin the first 6 patients showed a reduction of the previously elevated peaks to normal size and the appearance of a new peak ahead of the albumin peak containing from 3.7 to 16.9% of the total protein (Fig. 2). In the seventh patient no pre-albumin peak was observed. High speed centrifugation of the plasma at 18,000 revolutions per minute for one hour prior to electrophoretic analysis reduced the size of the pre-albumin peak; and rotation of the plasma with ethyl ether at +5 C. for one hour abolished it. Chemical analyses following the injection of heparin revealed in all 7 patients a decrease in the degree of turbidity and in the amounts of cholesterol and phospholipids; and in 5 patients also a decrease in the amount of neutral fat. The decrease in these values was moderate in the first 6 patients and considerable in the seventh patient (who had shown no pre-albumin peak). With the exception of the latter patient, the average decreases were: cholesterol from 663 mg/100 ml to 576 mg; phospholipids from 658 to 602 mg; and neutral fat from 1812 to 1665 mg. In the seventh patient, heparin was injected on three occasions and caused average decreases as follows: cholesterol from 592 mg/100 ml to 312 mg; phospholipids from 564 to 313 mg, and neutral fat from 4900 to 3049 mg.

Fractionation of the plasma proteins according to a modification of Cohn's method 10 (*2*) revealed that the elevations of the β-1 peak in xanthomatosis and

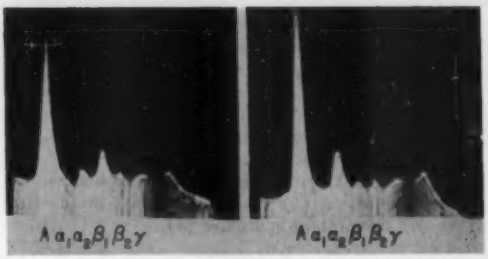

FIG. 1. Electrophoretic patterns in primary hypercholesteremic xanthomatosis. Left, fasting plasma: the β-1 peak is abnormally high. Right, plasma after the injection of heparin: the β-1 peak now is smaller than normal while the α-2 peak has increased in size. (Determinations were carried out in a Perkin-Elmer Tiselius electrophoresis apparatus using as buffer sodium diethylbarbiturate-sodium citrate at pH 8.6 and an ionic strength of 0.1 Field strength: 200 v, 9 ma. Time of run: 55 min.)

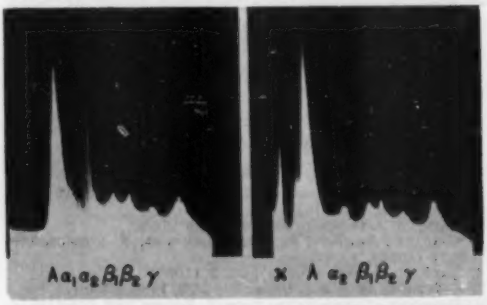

FIG. 2. Electrophoretic patterns in idiopathic hyperlipemia. Left, fasting plasma: the α-2 peak is abnormally high. Right, plasma after the injection of heparin: the α-2 peak is reduced to normal size, and a new peak, marked x, has appeared in front of the albumin peak.

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of the α-2 and β-1 peaks in hyperlipemia were caused by a lipoprotein with the solubility characteristics of β-1 lipoprotein. There are two possible reasons for the increase in the speed of electrophoretic migration of the β-1 lipoprotein after the intravenous injection of heparin: either combination with heparin (which has a high negative charge) increases the negative net charge of the β-1 lipoprotein molecules, or heparin by its lipolytic action (*3*) causes a decrease in the size of the β-1 lipoprotein molecules (*4*).

References

1. LEVER, W. F., SMITH, P. A. J., and HURLEY, N. A. *J. Invest. Dermatol.* To be published.
2. LEVER, W. F., *et al. J. Clin. Invest.*, **30**, 99 (1951).
3. SHORE, B., NICHOLS, A. V., and FREEMAN, N. K. *Proc. Soc. Exptl. Biol. Med.*, **83**, 216 (1953).
4. HERBST, F., and HURLEY, N. A. To be published.

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The Metabolism of Niacin in Insects[1]

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A number of studies have demonstrated species differences in the metabolism of niacin. In carnivorous mammals the principal end product, as evidenced by urinary excretion, is N^1-methyl nicotinamide (NMN). In contrast, species of herbivora do not excrete appreciable amounts of NMN (*1*).

The present author has reported that the urinary excretion of NMN could not be detected following the subcutaneous injection of nicotinamide in the herbivorous insect, *Bombyx mori* (*2*). The urine analyses were done by the author's method (*3, 4*). The methylation of nicotinamide has not yet been demonstrated in other insects.

Hence the methylation of nicotinamide was looked for in the carnivorous insect, *Lucilia caesar*, L. which had been fed with fish protein in the larval stage. The urine of the last pupal stage before emergence was examined for NMN by paper chromatography (*4*), using a urea butyl alcohol solvent (*5*) and Dragendroff's reagent (*6*). No NMN was found in the urine. Control experiments indicated that 10 μg of NMN added/ml of Lucilia urine could be detected by the method used. The failure to find N-methyl nicotinamide in the urines of either a carnivorous insect or an herbivorous insect (*2*) suggests that the metabolism of nicotinamide in insects is different from that in carnivorous mammals.

References

1. PEARSON, P. B., PERLSWEIG, W. A., and ROSEN, F. *Arch. Biochem.*, **9**, 191 (1949).
2. KATO, M. *J. Sericult. Sci. Japan.* In press.
3. KATO, M., SHIMIZU, H., and HAMAMURA, Y. *Science*, **116**, 3017 (1952).
4. KATO, M. *Science (Japan)*, **23**, 9 (1953).
5. CARTER, C. E. *J. Am. Chem. Soc.*, **72**, 1466 (1950).
6. KARIYONE, T., and HASHIMOTO, Y. *Nature*, **168**, 739 (1951).

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A Discontinuous Paper Drive

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A discontinuous paper drive for use with paper ionophoresis strips containing radioactive samples has been designed and built similar to that shown in Fig. 1. The apparatus pulls 3.5-cm-wide strips of paper

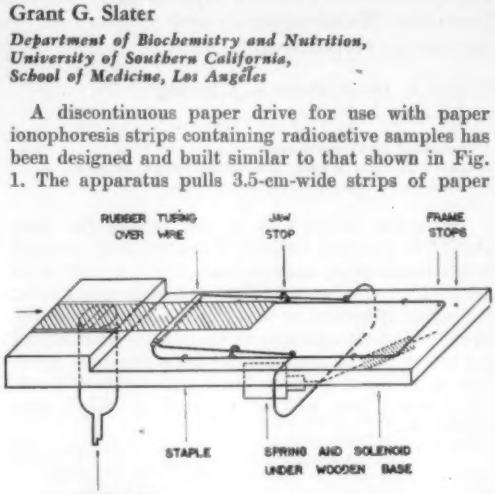

FIG. 1. Drawing of discontinuous paper drive.

over a thin window Geiger tube but could be used on various widths of paper. Construction of the paper drive was from clothes hanger wire, rubber tubing, nails, one solenoid, one spring, and ½-in. plywood. The wire jaw runs through loops in the wire frame and connects to the solenoid. The solenoid opens the jaws against the jaw stops and moves the frame backward. Then, the spring closes the jaws on the paper and moves the frame and paper any desired distance up to 1.5 cm, depending on where the frame stops are placed.

In use the solenoid is connected to a scaler such that any predetermined count will activate the solenoid. A pen, which makes a mark on a constant speed paper tape so that the exact cross section containing activity can be determined, is also connected in parallel.

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Survival of Irradiated Rats in Parabiosis with Hypophysectomized Partners[1]

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Brecher and Cronkite (*1*) first demonstrated that postirradiation parabiosis is a means of altering the effect of a lethal dose of x-irradiation to rats. Their results have been confirmed and extended during the

[1] This investigation was supported in part by a research grant (C-1728 Rad) from the National Cancer Institute of the National Institutes of Health, Public Health Service.

last 2 yr (*2, 3*). Furthermore, it has been demonstrated that removal of either adrenal glands or spleen from the nonirradiated partner does not significantly alter the postirradiation protection afforded by parabiosis (*4*). In view of these findings it seemed pertinent to determine the influence of certain endocrine glands on irradiation protection by pairing irradiated rats with nonirradiated, hypophysectomized partners. If a parabiont without a pituitary gland were still capable of protecting its partner from irradiation death, much speculation concerning the role of the endocrine system in irradiation protection might be eliminated.

Holtzmann female littermate rats were used throughout this investigation and experimental procedures were carried out when the animals were about 40 days of age and had attained a weight of 120 ± 5 g. The parapharyngeal approach without cannulation of the trachea was used for hypophysectomy and the operation usually preceded the pairing by 2–3 days. All rats to be irradiated were placed in plastic boxes and exposed to ionizing radiation with the following physical factors: 250 KV, 30 ma, 0.25 Cu and 1.0 Al filtration, HVL 0.88 Cu, 50 cm FSD, 20 × 20 cm field, and an intensity of 127 r/min. The animals were exposed to a dose of 700 r which previously had been determined as the LD 98/30 days in this laboratory. The animals were divided into 4 groups and all consisted of parabionts except the first which was composed of 65 single irradiated controls. Parabiosis was carried out under Nembutal anesthesia, according to the method of Bunster and Meyer (*5*), within 3 hr after exposure to x-ray. Unless death intervened, animals were observed for a 30-day period, at which time surgical separation of the pairs was done under ether anesthesia. At the same time the hypophysectomized partners were sacrificed in order to determine completeness of the operation. Sella turcicas were checked grossly and microscopically.

Results are summarized in Table 1. Of the 65 single animals exposed to 700 r, only one survived the 30 day observation period and that one succumbed on the 75th postirradiation day. Twenty-three nonirradiated–nonirradiated pairs made up the 2nd group and of these 16 survived 30 days for a survival rate of 70%. A small group of irradiated–irradiated parabionts served as further controls for parabiosis and as was expected, mortality of these pairs was complete. In most cases deaths occurred somewhat earlier than in the single irradiated animals, presumably due to the added stress of the operation. Irradiated-hypophysectomized pairs make up the last group and of the original 22 pairs, 16, or 73%, survived 30 days or longer. Only those pairs in which the hypophysectomized partner showed no remnants of the hypophysis have been included. A significant difference exists between survival in the unpaired irradiated control group and survival in the group of irradiated animals with hypophysectomized partners ($P < 0.01$).

The effects of parabiosis are shown in the irradiated-irradiated and nonirradiated-nonirradiated parabionts. In the former group death was considered to be only a result of irradiation since it occurred within the first 5 or 6 days. Deaths in the latter group, which was not irradiated, were attributed primarily to parabiosis intoxication, a condition peculiar to parabiotic animals (*6*). In the irradiated-hypophysectomized group both factors were responsible for the mortality.

TABLE 1

Treatment*	No. of pairs	Survival at 30 days following irradiation
Unpaired irradiated	65	1 (2%)
Nonirradiated–nonirradiated	23	16 (70%)†
Irradiated–irradiated	10	0
Irradiated-hypophysectomized	22	16 (73%)†

* All irradiated animals received 700 r.
† Statistically significant difference from unpaired irradiated rats.

This experiment represents one of a series in which the mechanism of postirradiation protection by parabiosis is being sought. Previous work has shown that neither the adrenals nor the spleen are necessary in the nonirradiated partner to produce the protection. Now, good protection has been described when irradiated rats were paired with nonirradiated, hypophysectomized animals. Work of this nature tends to eliminate the role of the hypophysis and its dependent endocrine organs as critical factors in recovery from irradiation sickness.

References

1. Berchер, G., and Cronkite, E. P. *Proc. Soc. Exptl. Biol. Med.*, **77**, 292 (1951).
2. Finerty, J. C., Binhammer, R., and Schneider, M. *Tex. Repts. Biol. Med.*, **10**, 496 (1952).
3. Binhammer, R. T., Schneider, M., and Finerty, J. C. *Am. J. Physiol.* In press.
4. Schneider, M., *et al. Radiology.* In press.
5. Bunster, E., and Meyer, R. K. *Anat. Record*, **57**, 339 (1933).
6. Finerty, J. C. *Physiol. Revs.*, **32**, 277 (1952).

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Accumulation of Acid-Soluble Nitrogen in the Brain Cortex of Cats During Stimulation

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In the experiments described below it is shown that trichloracetic filtrates of brain cortex frozen during stimulation contain considerably more nitrogenous compounds than those of homologous areas taken at rest.

Small increases in the concentration of ammonia in the brain during stimulation have been described by

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[2] The authors wish to express their appreciation to M. Samueloff for his help with the experiments.

TABLE 1

INCREASE OF NPN IN THE BRAIN DURING STIMULATION

Expt.	Cortical area	NPN mg % in TCA filtrate: Non-stimulated hemisphere frozen 2 sec before stimulation	NPN mg % in TCA filtrate: Hemisphere stimulated through contralateral brachial plexus	Duration of stimulation, sec
1	Frontal	164	167	7
	Central	174	193	
	Occipital	184	189	
2	Frontal	130	138	7
	Central	150	168	
	Occipital	153	164	
3	Frontal	91	108	20
	Central	149	178	
	Occipital	180	185	
4	Frontal	108	164	15
	Central	142	168	
	Occipital	149	163	
5	Frontal	155	182	15
	Central	170	202	
	Occipital	187	187	
6	Frontal	140	175	15
	Central	152	205	
	Occipital	173	193	
7	Whole frontal and central	106	152	15
Demonstration of reversibility: both hemispheres frozen 40 sec after stimulation				
1	Frontal	125	115	15
	Central	132	124	
	Occipital	178	178	
2	Frontal	102	100	15
	Central	148	151	
	Occipital	181	177	

previous investigators (*1*); these changes, however, were of the order of less than 1 mg % N.

In the present experiments the brain cortex in Nembutal narcosis was stimulated either through directly applied electrodes, or through the contralateral brachial plexus with ac of 40 v and 75 c, after the removal of the skull over a wide area. The nonstimulated hemisphere was frozen 2 sec before starting stimulation, by applying a metal container filled with solid CO_2 and acetone. Freezing was instantaneous, and the temperature of the opposite hemisphere remained unaffected 7–8 sec. After a period of stimulation lasting 7–15 sec, the other hemisphere was also frozen and the frozen areas were cut out and divided into frontal, central, and occipital parts. Most of the white matter was sliced off, leaving slices about 2.5 mm thick, consisting mainly of gray matter, which were homogenized in their frozen state in 10% trichloracetic acid.

In the filtrates, total N was determined by Nesslerization after digestion with sulfuric acid and potassium persulfate. Amino-N was estimated by the method of Moore and Stein (*2*). Volatile bases were liberated and estimated, according to Dobkin (*3*), by treating the neutralized TCA filtrates with alkaline potassium permanganate in Conway dishes at 38° C overnight and titrating the mixture of bases collected in the acid compartment. From similarly treated duplicates, the contents of the central compartment were transferred into the outer chamber of another Conway dish, and, after the addition of formaldehyde and alkali, the trimethylamine present in the mixture was distilled into standard acid and titrated. Choline was calculated on the basis of the trimethylamine thus found.

In a large number of preliminary experiments, it was ascertained that the nonprotein nitrogen concentration in homologous areas of both hemispheres was practically identical at rest. In different cortical areas of the same hemisphere, however, the nonprotein N concentrations varied, being lowest in the frontal and highest in the occipital areas.

The results obtained by direct stimulation of the cortex were identical with those obtained when the brachial plexus was stimulated. In the experiments presented in Table 1, the cortex was stimulated through the brachial plexus.

The changes in the NPN content of the cortex during stimulation were very marked, mainly in the central and frontal areas. In the latter, the average increase of NPN during stimulation was around 25 mg % N. In some experiments, 40–60 sec after discontinuing stimulation the differences between stimulated and resting areas had disappeared. In most reversion occurred only after the lapse of 10–20 min.

The amino-N concentration was lower in the directly stimulated areas than in the corresponding resting areas, as shown in Table 2. These differences were less marked when the brachial plexus was stimulated.

In the majority of experiments, higher amounts of volatile bases were released by alkaline permanganate treatment from the TCA filtrates of the stimulated cortex than from corresponding resting areas of the opposite hemisphere. The amount of volatile bases found during stimulation was usually very close to 35 meq/kg. There was no increase in the concentra-

TABLE 2

EFFECT OF DIRECT STIMULATION OF THE BRAIN CORTEX ON NH_2-NITROGEN, AS MEASURED BY MOORE AND STEIN NINHYDRIN COLORIMETRIC METHOD

Date	Area	NH_2-nitrogen mg %: Non-stimulated	NH_2-nitrogen mg %: Stimulated
10/3	Central	52	46.0
10/3	Central	43	39.5
10/3	Central	55	41.0
16/3	Central	43	39.0
19/3	Central	47	38.5
23/3	Central	46	42.5
7/4	Central	45	41.0
	Frontal	78	54.0
4/5	Central	63	46.4
	Occipital	56	42.6

TABLE 3

VOLATILE BASES RELEASED FROM TCA EXTRACT OF BRAIN CORTEX BY OXIDATION WITH ALKALINE $KMnO_4$

Expt.	Area	N mg % non-stimulated	Stimulated
1	Frontal and central	23.0	32.0
2	Frontal and central	22.0	43.0
3	Frontal	31.5	32.5
	Central	33.0	43.0
	Occipital	39.5	43.5
4	Frontal	39.5	45.0
	Central	45.0	45.0
	Occipital	44.5	47.5
5	Frontal and central	36.8	50.0

tion of these bases during stimulation in spite of a considerable increase of NPN, when their resting concentration reached this figure.

References

1. RICHTER, D. *Biochem. Soc. Symposia, Cambridge, Engl.*, **8**, 62, (1952).
2. MOORE, S., and STEIN, W. H. *J. Biol. Chem.*, **176**, 367 (1948).
3. DOBKIN, J. To be published.

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Effect of Phosphorylated Hesperidin and Other Flavonoids on Fertility in Mice

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Several reports have appeared recently concerning the antifertility activity of phosphorylated hesperidin, a compound previously shown (*1*) to be a hyaluronidase inhibitor. This derivative of hesperidin has been reported to prevent conception in rats (*2*), mice, and humans (*3*) when administered orally or intraperitoneally. However, Chang and Pincus (*4*) were unable to confirm the reported activity of phosphorylated hesperidin, and furthermore indicated that a hyaluronidase inhibitor would not necessarily be an inhibitor of fertilization. Subsequently Martin (*5*) reported that the phosphorylated hesperidin as originally used was a mixture of phosphates, only one of which acts as an antifertility agent.[1]

In the present investigation, initiated before publication of the reports by Chang and Pincus (*4*) and Martin (*5*), three flavonoids, phosphorylated hesperidin,[2] dihydroquercetin, and hesperidin methyl chalcone were tested for antifertility activity in mice. Rodney *et al.* (*6*) have shown that dihydroquercetin inhibits hyaluronidase *in vivo* to a greater extent than most of the other flavonoids tested by these investigators. Although hesperidin methyl chalcone does not inhibit hyaluronidase (*6, 7*), it seemed of interest to include this compound in the antifertility tests because of its similarity in structure with the two other flavonoids being tested.

[1] Following the completion of this paper for publication, Millman and Rosen (SCIENCE, **118**, 212 [1953]) reported that phosphorylated hesperidin did not reduce fertility in mice or rats treated orally or by intraperitoneal injection.

[2] We wish to thank G. J. Martin, of the National Drug Co., Philadelphia, for supplying the phosphorylated hesperidin.

TABLE 1

PREGNANCY IN MICE

Group No.	Compound*	No. males	No. females	No. pregnant	Gestation period† days
1–6	None	6	24	22	21–34
7, 8	Phosphorylated hesperidin	2	8	8	21–30
9, 10	Dihydroquercetin	2	8	6	21–31
11, 12	Hesperidin methyl chalcone	2	8	8	21–23

* Each compound incorporated in diet at a level of 0.875 g/kg.

† Refers to number of days from the time male was introduced to the female to the day of parturition.

Weanling mice were separated according to sex and maintained on a laboratory breeding ration consisting of ground grains, alfalfa leaf meal, brewers' yeast, and whole liver powder until the mice were 7 wk old. At this time 3 females were placed with each male for fertilization. Pregnancy records were kept for each group. Following the parturition of their first litter, 48 fertile females were arranged in 12 groups of 4 each. In addition, 12 males of proved fertility were housed individually. Each of the 3 flavonoids to be tested for antifertility activity was incorporated at a level of 0.875 g/kg of the breeding ration, respectively. Since 5–6 g of diet were consumed/day/mouse (weighing 25–35 g), the level of flavonoid used afforded an intake of approximately 150 mg/day/kg of body weight. Two groups of females and 2 males were maintained on the respective diets 10–12 days prior to placing the males with the females. Each group continued to receive their respective diets during mating. The remaining 6 groups of females and males received the unsupplemented breeding ration and served as controls. About 2 wk following the introduction of the male, the females were examined daily for pregnancy and removed from the male if pregnant. The data obtained are presented in Table 1. The results of this investigation indicate that fertility in mice was not affected by any of the compounds tested under the conditions of this study.

References

1. BEILER, J. M., and MARTIN, G. J. *J. Biol. Chem.*, **174**, 31 (1948).
2. MARTIN, G. J., and BEILER, J. M. *Science*, **115**, 402 (1952).
3. SIEVE, B. F. *Ibid.*, **116**, 373 (1952).
4. CHANG, M. C., and PINCUS, G. *Ibid.*, **117**, 274 (1953).
5. MARTIN, G. J. *Ibid.*, 363 (1953).
6. RODNEY, G., *et al. J. Biol. Chem.*, **183**, 739 (1950).
7. BEILER, J. M., and MARTIN, G. J. *Ibid.*, **171**, 507 (1947).

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Book Reviews

Symposium on Chromosome Breakage. (Suppl. to *Heredity,* 6 [1953]). Held at the John Innes Horticultural Institution, June 9–11, 1952. London–Edinburgh: Oliver & Boyd, 1953. 315 pp. Illus. + plates. $7.50.

Chromosome breakage is a fundamental factor in biology. It is related to gene mutation, structural changes in the chromosomes, and crossing over, all of which are basic factors in the evolution of plants and animals. The killing of cells with ionizing radiation is associated with chromosome breakage and is an important factor in cancer therapy. The artificial production of chromosome breaks with ionizing radiation and chemicals has provided a tool for the chemical and physical analysis of chromosome structure and behavior.

The symposium on chromosome breakage held at the John Innes Horticultural Institution in 1952 included material on radiation breakage, chemical breakage, secondary and spontaneous breakage, and a general section dealing largely with biochemical problems. With the exception of Professor Oehlkers of Freiburg, all the contributors were from England, and the discussion was based largely on the work of English cytogeneticists, cytologists and biochemists.

Most of the radiation work on chromosome breakage was based upon the analysis of *Tradescantia* chromosomes. Koller described the various cytological effects of ionizing radiation. The physiological effects result in chromosome stickiness, suppression of mitosis, aberrations in spindle formation and centromere misdivision. At low intensities there is evidence of a stimulating effect which increases the rate of mitosis. This observation is of particular interest in view of the many reports of a stimulating effect of low doses on plant growth.

The genetic effects involve chromosomes and chromatid breakage, resulting in chromosome and chromatid deletions and the exchanges, dicentrics, and rings produced by fusion of broken ends of chromosomes and chromatids. The frequencies of breakage and reunion are reduced when irradiation is reduced from high to low intensities. Koller attributes this decrease in part to the physiological effect of radiation.

Lane's experiments show that fractionation of the dosage with rest periods up to 4 hours results in a decrease of chromosome aberrations. With longer rest periods up to 12 hours, the aberration frequency increases until it approaches that induced by the same total dosage given in a single exposure. The decline in aberration frequency with fractionation of the dosage is attributed to a physiological suppression of breakage by the first exposure. With longer rest periods, the cells recover their sensitivity and the aberration frequency increases. No satisfactory explanation is given to explain the drop in aberration frequency when the rest period is increased to 18 hours. Similar experiments by Haque support Lane's results. Both authors conclude that the decrease in aberration frequency following fractional dosage or low intensity irradiation cannot be attributed to healing of broken ends of chromosomes, as various investigators in the United States and England have assumed.

Radiation of meiotic cells results in a series of physiological effects which disturb both spindle and chromosome behavior. Darlington and La Cour found that breaks induced at first metaphase are not evident until the second division, due to the close association of chromatids until interphase. They no longer maintain that the metaphase chromosomes are protected against radiation breakage by their accumulation of nucleic acid. Haque finds the meiotic divisions about 20 times as sensitive to irradiation as are the mitotic divisions in the microspore of *Tradescantia.* Many of the breaks induced at meiosis remain "open" to give rise to chromatid aberrations in microspore divisions occurring 4 to 6 days after irradiation.

The various types of aberrations found by Darlington and his students are referred to by code letters. The code system is not explained and the reader is referred to an earlier paper by Darlington and La Cour. It is possible to decipher the code by referring to the description of figures, but the complex system is confusing.

The first section of the symposium also includes a report on chromosome division in *Luzula* by La Cour. The effects of radiation treatment indicate that the chromosomes are polycentric rather than having a diffuse centromere system. Morrison finds that x-rays induce polyploidy as well as chromosome aberrations in *Triticum.*

The contributions of Thoday and Gray deal largely with x-ray-induced chromosome aberrations, although they are included in the general section. Thoday's work with *Vicia* supports the target theory and shows that chromosome breakage can occur both before and after the splitting of the chromosome into chromatids, as has been observed in *Tradescantia.* Gray's analysis of chromosome breakage by different ionizing agents and modifying factors also supports the target theory, as elaborated by Lea.

Chromosome breakage by chemicals differs in many respects from that induced by ionizing radiations. Oehlkers finds that in *Oenothera* chromosomes there are regions of differential breakability and differential sensitivity. According to Revell, chemically (diepoxide) induced aberrations in *Vicia* chromosomes occur at limited times in the cell cycle, and the frequency of aberrations does not vary with dosage intensity. The chemical action is indirect and chromosome association is necessary for the production of the aberrations. Maleic hydrazide, a growth suppressor, also induces localized chromosome breakage. It suppresses growth in all plant tissue, but breaks only chromosomes which are heterochromatic. McLeish

therefore concludes that the two processes are not directly connected.

In an analysis of *Drosophila* chromosomes, Fahmy and Bird found that diepoxide and triazine produced a higher proportion of small deficiencies than did x-rays or mustard gas. Lethals with rearrangements increase more than linearly in relation to dose, while lethals without chromosome rearrangements show less than a linear relation to dosage.

The section on secondary and spontaneous breakage involves a heterogeneous collection of articles. La Cour's analysis of *Hyacinthus* chromosomes shows that chromatid reunions at the second division must be attributed to deferred union or deferred breakage. Koller finds that chemically induced tumors in rats occasionally show recurrent chromosome breakage. This spontaneous breakage was suppressed when the tumor was grown in tissue culture. A somewhat similar dicentric chromosome cycle was found in *Narcissus* by Darlington and Wylie. The cycle is permanent, but union of broken chromosomes ends may be limited by spatial or physiological limitations. In *Agropyron* also, the breakage-fusion-bridge cycle of dicentrics may fail if the breakage is not proximate, because of healing of broken ends. Hair found that some of the new chromosomes produced by breakage of dicentric bridges improved the efficiency of pairing and the genetic balance. Rees describes abnormal chromosome separation at anaphase in *Scilla* following irradiation, and due to the physiological effects of x-rays. Auerbach's analysis of the sensitive stage of *Drosophila* gonads shows that x-rays and mustard gas are most mutagenic at the stages of active nuclear synthesis, but that formaldehyde is most effective on the mature spermatozoa. This variation in sensitivity to mutagenic agents may provide data of value in the analysis of the causal factors in mutation.

The general section of the symposium deals largely with chemical factors in chromosome breakage. Irradiation not only decreases mitotic activity and results in chromosome breakage, but it also depresses the synthesis of deoxyribonucleic acid (DNA). Howard and Pelc used P^{32} intake in *Vicia* roots to measure DNA synthesis, and found that neither repression of division nor chromosome breakage caused by irradiation seems to be associated with DNA synthesis; but, as Walker points out, the determination of the amount and nature of DNA is subject to error.

The molecular orientation of the chromosome in relation to breakage is considered by Ambrose and Gopal-Ayengar. A comparison of fresh salivary gland chromosomes and oriented nucleoprotein fibers indicates that the longitudinal cohesive forces are due largely to hydrogen bonds. Certain chemicals could act directly on the hydrogen bonds, but others such as the diepoxides and nitrogen mustards probably result in a defect of synthesis. Ionizing radiation could disperse the bonds by localization of energy or by producing radicals which break primary bonds. A mechanism for uniting broken ends of chromosomes, one which would not disturb the reproductive system, is described. Loveless proposes the rather unorthodox suggestion that the chromosomes do not have a structural continuity, so that the problem of chromosome breakage is based upon failures in chromosome synthesis.

The variation in the time frequency and nature of induced chromosome breaks in different tissues and organisms, the differential effects of various mutagenic agents, and the effects of modifying factors, all indicate the complexity of the problems of chromosome breakage. The great variation does, however, provide a method of analysis of the various factors involved in chromosome breakage and reunion. The complexity of the problems of chromosome breakage are even greater than the symposium would indicate, because the conclusions on the action of ionizing radiation are based largely upon the work of the John Innes cytologists. The symposium has raised far more questions than it has answered.

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Stochastic Processes. J. L. Doob. New York: Wiley; London: Chapman & Hall, 1953. 654 pp. $10.00.

This book, one of the volumes in the series of Wiley Publications in Mathematical Statistics, is written for mathematicians. It seems to me that the author's hope that it may be accessible to readers familiar with the manipulation of random variables conditional probability distributions and conditional expectances is rather optimistic.

The first chapter describes the probability background of stochastic processes and in the second chapter the author describes the various classes of stochastic processes which are discussed in detail in chapters III to XI. These classes are processes with mutually independent random variables (ch. III), processes with mutually uncorrelated or orthogonal random variables (ch. IV), Markov processes (with discrete parameter, ch. V; with continuous parameter, ch. VI), martingales—the fortune of a gambler taking part in a fair game is a typical example of a martingale—(ch. VII), processes with independent and orthogonal increments (chs. VIII and IX), and stationary processes (chs. X and XI). The last chapter discusses prediction theory and the book concludes with a supplement giving the necessary elements of measure theory, an appendix with historical notes, a bibliography to this appendix, and a subject index.

Stochastic Processes seems to give a comprehensive and authoritative account of the mathematical background of the subject. The references to applications, which to my mind are far too few, are excellent and lucid. It is to be regretted that probability theory has now developed into a branch of measure theory and that modern developments in this subject are often couched in a language that is almost incomprehensible to ordinary experimental scientists and to most theoretical physicists. Since the language used in this

book is so highly specialized and technical, it is regrettable that the author did not include an extensive glossary of the symbols and notation used.

A personal point of regret was that, although the author mentions that in many modern problems in physics or astronomy it is necessary to abandon the requirement of normalizability of probability, he did not discuss some applications to cases where this impossibility of normalizing the probability would occur. This problem is, for instance, important for the discussion of the attainment of equilibrium in open star systems.

Concluding I can only congratulate the author and the publishers on producing this volume which for quite some time will be the main reference book for mathematicians on stochastic processes, if the signs do not deceive me.

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Inorganic Thermogravimetric Analysis. Clément Duval. Amsterdam–Houston: Elsevier, 1953. 548 pp. Illus. $11.00.

Occasionally a book appears which attracts special attention because an old subject is treated from a new approach. Here for the first time in a monograph is given a complete study of the stability to heating between 20 and 1000° C of 967 precipitates which have been proposed for inorganic gravimetric analysis. The results of the investigations of the author and his co-workers have been published in *Analytica Chimica Acta*. There is also a historical review of the development of the subject since the thermobalance was introduced by Honda in 1915, and a complete description of the Chenevard balance which was used.

The pyrolysis curves show the temperature range in which relatively constant composition is obtained. In some cases it is now evident that excessive heating of precipitates with a blast lamp to obtain a constant weight is unnecessary. For example, magnesium ammonium phosphate reaches a constant weight in an open crucible above 477° C and it is useless to ignite at 900° C. On the other hand, the asbestos mat on a Gooch crucible remains constant after the water is driven off as far at 283° C. Above this temperature there is a gradual loss of water which is complete only at 879° C.

The pyrolysis curves for all the precipitates are given in 152 illustrations with a critical discussion in brief paragraphs for each of the precipitates. There are also 980 references to the literature. About 210 methods were selected as satisfactory for gravimetric determinations and about 80 new methods were brought to light.

The book is well written and is undoubtedly a valuable source book for those interested in inorganic gravimetric methods.

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Books Reviewed in THE SCIENTIFIC MONTHLY

October

Africa: A Study in Tropical Development. L. Dudley Stamp. New York: Wiley; London: Chapman & Hall, 1953. 568 pp. Illus. + maps. $8.50.
Reviewed by George B. Cressey.

Explorations in Science. Waldemar Kaempffert. New York: Viking Press, 1953. 296 pp. $3.50.
Reviewed by G. G. Simpson.

The History of Astronomy. Giorgia Abetti, trans. by Betty Burr Abetti. New York: Schuman, 1952. 338 pp. Illus. $6.00.

Astronomy for Everyman. Martin Davidson, Ed. New York: Dutton, 1953. 494 pp. Illus. $5.00.
Reviewed by James Stokley.

Man and the Chemical Elements. J. Newton Friend. New York: Scribner, 1953. 354 pp. Illus. + plates. $6.00.
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Hungry People and Empty Lands. S. Chandrasekhar. Baroda, India: Indian Institute for Population Studies, 1952. 306 pp. Illus. $3.50.
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Man's Foods. J. B. Jensen. Champaign, Ill.: Garrard Press, 1953. 278 pp. $4.50.
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Elements of Cartography. A. H. Robinson. New York: Wiley, 1953. 254 pp. Illus. $7.00.
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Weather Inference for Beginners. D. J. Holland. New York: Cambridge Univ. Press, 1953. 196 pp. Illus. $6.00.
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Adventures in Artificial Respiration. Peter V. Karpovich. New York: Association Press, 1953. 303 pp. Illus. $7.50.
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Man and His Physical Universe. Richard Wistar. New York: Wiley, 1953. 488 pp. Illus. $4.75.
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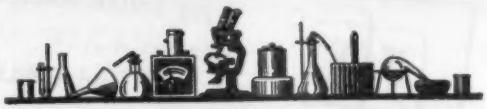

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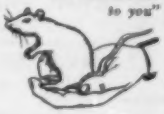

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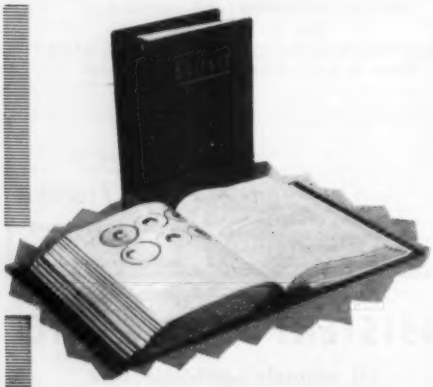

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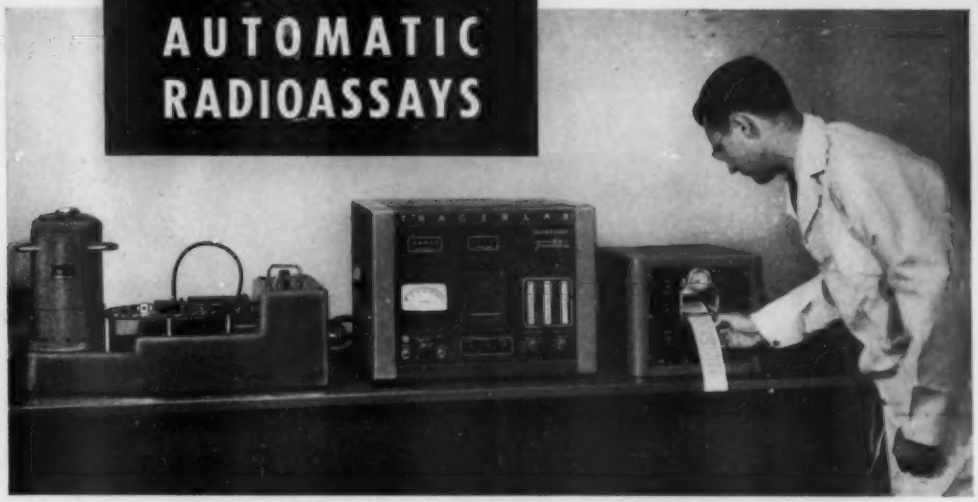

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